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ENERGY TECHNOLOGY TRANSFER TO CHINA

A TECHNICAL MEMORANDUM

SEPTEMBER 1985

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CONGRESS OF THE UNITED STATES
Office of Technology Assessment
Washington, D.C. 20510

J952-42

Recommended Citation:

U.S. Congress, Office of Technology Assessment, *Energy Technology Transfer to China—A Technical Memorandum*, OTA-TM-ISC-30 (Washington, DC: U.S. Government Printing Office, September 1985).

Library of Congress Catalog Card Number 85-600570

For sale by the Superintendent of Documents
U.S. Government Printing Office, Washington, DC 20402

Foreword

This technical memorandum responds to requests by the Senate Committee on Banking, Housing, and Urban Affairs and the House Committee on Energy and Commerce and its Special Subcommittee on U.S. Trade with China. It is the result of the first phase of OTA's assessment on Technology Transfer to China, which is scheduled to be completed by the end of 1986. Both committees requested that an interim document on energy technology be provided because of the immediacy of the agreement on nuclear cooperation and the importance of energy to China's modernization plans.

This memorandum examines the opportunities for the transfer of various energy technologies to China. It reviews the motivations for U.S. companies and other institutions for transferring technology and the vehicles for doing so. It also surveys China's needs for energy technologies and its ability to assimilate them.

Some implications of energy technology transfer are clearly important to U.S. interests. Certain technologies could enhance China's ability to compete against the United States in the world market or contribute to an increased military capability which could be of concern if relations deteriorate. On the other hand, technology transfer could be a major element in improving relations between the two countries, as well as an important component of increased U.S. trade with China.

Nuclear technology is given special attention in this memorandum because of the importance of exports to the U.S. nuclear industry, the potential impact on U.S. nonproliferation and strategic goals, and the interest of Congress in the nuclear cooperation agreement.

The memorandum also examines policies for controlling and promoting technology transfer to China. It analyzes changes that might improve the effectiveness of these policies.

The memorandum is based on discussions at a workshop held on April 18-19, 1985, on five background papers commissioned for this workshop and on OTA staff research. The five papers and additional information are contained in a separate volume.

OTA appreciates the assistance provided by the workshop participants; reviewers of this document; and the many individuals, companies, and agencies contacted during the study.

John H. Gibbons

JOHN H. GIBBONS
Director

Related OTA Reports

Technology Transfer

- *U.S.-Soviet Cooperation in Space.*
  OTA-TM-STI-27, July 1985. GPO stock #052-003-01004-6.
- *Technology Transfer to the Middle East.*
  OTA-ISC-173, September 1984. GPO stock #052-003-00962-5.
- *Technology and East-West Trade: An Update.*
  OTA-ISC-209, May 1983. GPO stock #052-003-00908-1.
- *Technology and Soviet Energy Availability.*
  OTA-ISC-153, November 1981. NTIS order #PB 82-133 455.
- *Technology and East-West Trade.*
  OTA-ISC-101, November 1979. NTIS order #PB 80-119 381.

Energy

- *New Electric Power Technologies: Problems and Prospects for the 1990s.*
  OTA-E-246, July 1985. GPO stock #052-003-01005-4.
- *Nuclear Power in an Age of Uncertainty.*
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- *Industrial and Commercial Cogeneration.*
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- *Industrial Energy Use.*
  OTA-E-198, June 1983. GPO stock #052-003-00915-3.
- *Nuclear Proliferation and Safeguards, Summary.*
  OTA-E-148, March 1982.
- *Direct Use of Coal: Prospects and Problems of Production and Combustion.*
  OTA-E-86, April 1979. NTIS order #PB 295 797.

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OTA Project Staff for Energy Technology Transfer to China

Lionel S. Johns, *Assistant Director, OTA*
Energy, Materials, and International Security Division

Peter Sharfman, *International Security and Commerce Program Manager*

Alan T. Crane, Project Director

Martha Caldwell Harris, Senior Analyst
Richard P. Suttmeier, Senior Analyst
Joanne Sedor, Analyst
Craig Allen, Research Assistant

Administrative Staff

Jannie Coles
Dorothy Richroath
Jackie Robinson

Energy Technology Transfer to China Workshop

Allen S. Whiting, *Chairman*
University of Arizona

Kenneth Angell
Overseas Private Investment Corp.

Baruch Boxer
Rutgers University

Hugh Donaghue
Control Data Corp.

Warren Donnelly
Library of Congress

Thomas Fingar
Stanford University

Wendy Frieman
SAIC

Ronnie Lee Goldberg*
New York Chamber of Commerce and Industry

Dixon Hoyle
Westinghouse Electric Corp.

Richard L. Hughes
Fluor China Inc.

Eric Larson
Princeton University

Kenneth Lieberthal
University of Michigan

Jonathan D. Pollack*
Rand Corp.

Thomas W. Robinson
Georgetown University

Richard Rowberg
Office of Technology Assessment

Cathy Ruckleshaus
Overseas Private Investment Corp.

Denis Fred Simon*
Massachusetts Institute of Technology

Leonard Spector
Carnegie Endowment for International Peace

Roger Sullivan
National Council for U.S.-China Trade

Richard Peter Suttmeier*
Hamilton College

Amy Wilson
National Academy of Sciences

Kim Woodard*
China Energy Ventures, Inc.

Reviewers

William J. Cherones
Harnischfeger Corp.

Peter Clausen
Union of Concerned Scientists

David Denny
National Council for U.S.-China Trade

Eldon V.C. Greenberg
Galloway & Greenberg

Paul L. Leventhal
Nuclear Control Institute

S.O. Ogden
Island Creek Coal Co.

Department of State

Department of Commerce

---

*Authors of background paper prepared for OTA.

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Chapter 1

Introduction

Chapter 1

Introduction

Since the normalization of relations between the United States and China in 1979, exports of U.S. energy-related equipment, services, and technology have increased dramatically. U.S. policies reflect the expectation that deepening ties can serve U.S. security interests in the region, while at the same time providing market opportunities for U.S. firms and opening doors to mutually enriching cultural and educational exchange.

Some observers, however, worry that the floodgates have been opened too quickly, permitting transfers that the United States or China may come to regret. As Confucius once said: "To go beyond is as wrong as to fall short." Others, however, see delays in U.S. export administration and other policy-related problems as obstacles to U.S. firms competing in the China market and as evidence that we lack a clearly defined strategy for promoting Chinese energy development. This memorandum addresses the central question of whether (and how) the flow of U.S. energy technology to China can help to serve U.S. foreign policy and commercial interests.

The transfer of technologies that China needs to develop its energy resources requires much more than the sale of equipment. Technology transfer is a process, involving at least two parties, whereby the Chinese firm or organization attains an improved capability to design or produce goods and services.[1] It involves people in a fairly intimate and extended dialog. In this process a number of commercial transactions occur, often simultaneously. These include payments for licenses and patents, provision of sophisticated equipment in which technology is embedded, training, and information exchanges between technical professionals in the China and abroad.

If the Chinese are to effectively select and use energy technologies developed abroad, their engineers and technicians will need specialized know-how to run these energy industries. They will also need to adapt the technology to China's environmental and industrial milieu. Much of the needed knowledge is not in cutting edge high technologies.[2] Instead, it is often more mundane, such as the knowledge needed to make appropriate selections among the more than 30 kinds of pipe connections used in the petroleum industry.

China's need for foreign energy technologies (including management skills) is illustrated by the fact that, in spite of abundant energy resources, the country is experiencing electricity shortages so severe that at times 20 to 30 percent of its industrial capacity remains idle.[3] As the discussion below documents in some detail, although the country has an extensive resource base, its future economic development will be directly and strongly affected by its success in meeting energy production goals. Imports of foreign technology could provide the avenue to accomplish what would take many more years if China had to go it alone. U.S. firms have been world leaders in developing most of the technologies that China needs, though other countries can also supply them.[4]

There is a clear complementarity between U.S. technological capabilities and China's requirements for developing its energy resources, but difficulties have nonetheless arisen in attempting to match these needs and capabilities. In the past, for example during the Cultural Revolution, China sought to limit its purchases to foreign hardware, underestimating the need for ongoing involvement with foreign suppliers. More recently, foreign firms were disappointed by the scaling back of Chinese plans in the early 1980s and were also surprised by China's hard bargaining tactics.

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[1] See U.S. Congress, Office of Technology Assessment, *Technology Transfer to the Middle East* (Washington, DC: U.S. Government Printing Office, September 1984), OTA-ISC-173, "Chapter 2: Analyzing Technology Trade and Transfer." See also Kim Woodard, Background Paper I, "Technology Transfer and China's Energy Industries," prepared for the Office of Technology Assessment, Apr. 18, 1985, for a detailed outline of the mechanisms for technology transfer to China, including training programs, joint management, and production.

[2] China is probably the largest buyer of used American mining equipment. See Thomas N. Thompson, "Selling Used Mining Equipment," *The China Business Review*, May-June 1985, pp. 16-17.

[3] See, for example, David Denny, "Electric Power and the Chinese Economy," *China Business Review*, July-August 1985. See also, Lu Qi, "Energy Conservation and Its Prospects," *Beijing Review*, No. 46, November 1984, for an estimate of 20 percent underutilization.

[4] Secretary of Commerce Malcolm Baldrige has indicated that the Chinese would prefr U.S. technologies over those of the Soviet Union or Japan. See "Chinese Technology Mart Touted," *Journal of Commerce*, May 31, 1985, p. 1.

The expectations and interests of the U.S. and Chinese enterprises directly involved in the transfers, as well the governments and other affected parties, sometimes diverge. For the U.S. firm with technology to sell and for the Chinese firm that needs the technology, the commercial rationale for technology transfers may be clear, at least in the short run. But from a U.S. Government perspective, questions of national security are raised, particularly when the transfers involve technologies with potential military applications. The potential long-term effects—commercial as well as strategic—must be carefully assessed in developing U.S. export control as well as promotional policies.

The pending agreement for cooperation in nuclear energy between the United States and China embodies many of these policy dilemmas. The risks as well as the opportunities associated with possible nuclear technology transfers have potential implications not only for the United States and China, but also for global trends in the proliferation of nuclear weapons. Congress has an important role to play in reviewing the proposed accord, and in helping to shape the policy context for conventional energy technology transfers to China.

Two congressional committees requested that OTA provide an interim report on energy technology transfers to China. The Senate Banking Committee, one of the requesters, plays a leading role in export policymaking and Members of the Committee are particularly interested in the proposed agreement for nuclear cooperation between the United States and China. The House Energy and Commerce Committee and its Special Subcommittee on U.S. Trade with China have asked OTA to examine how the U.S. Government might facilitate energy technology transfers while at the same time ensuring that national security interests are upheld.

Because of the keen interest in the area of energy technology transfers to China on the part of the requesting committees, OTA turned to these issues in the first stage of a major research project on "Technology Transfer to China" that will deal with a number of technologies. This memorandum is not meant to be definitive. Instead it raises a number of broader issues concerning U.S.-China relations that will be analyzed in more depth in the full report. The major OTA study was initiated in the spring of 1985 and is scheduled for completion in December 1986.

This memorandum is based on the research of OTA staff and the proceedings of a 2-day workshop held in April 1985 that included experts from academia, industry, and research institutes. The participants are listed in the front of this memorandum. The report is designed to present the policy issues that Congress will confront as it looks at the long-term risks and opportunities associated with transferring energy technologies to China. Five working papers that were commissioned for the workshop and other documents that provide additional information on the subject are included in a separate volume, available upon request to OTA.

Chapter 2

Technology Transfer and U.S.-China Relations

Chapter 2

Technology Transfer and U.S.-China Relations

The normalization of diplomatic relations between the United States and China that occurred in 1979 set the stage for rapidly expanding technology transfer and trade. The two countries have signed 25 protocols for cooperation in science and technology. More than 12,000 students from the People's Republic are now studying in the United States. The United States is China's third largest trading partner, after Japan and Hong Kong.

Energy has been a major focus of economic interaction between China and the United States. In the first quarter of 1985 U.S. firms sold $64.8 million in mining and well drilling equipment to China.[1] Occidental Petroleum recently signed an agreement to develop an open-pit coal mine in China that will be one of the world's largest. An agreement for cooperation in nuclear power, a priority energy development sector for China, was initialed in 1984 and recently signed on July 23, 1985.[2] This chapter examines the role of technology transfer in the bilateral relationship, and highlights opportunities and risks from the U.S. perspective.

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[1] See *China Business and Trade*, vol. VI, Issue 21, May 9, 1985, p. 1.

[2] The text of the agreement (included in the appendix) was first made public in July 1985. Congress is currently reviewing the document. The agreement may become effective in the fall of 1985, unless Congress adopts a joint resolution of disapproval. (See chapter 5.)

THE FOREIGN POLICY CONTEXT FOR TECHNOLOGY TRANSFER

The United States and China are important countries whose expanding relationship is potentially significant in global geopolitics. Officials in three U.S. Administrations have concluded that the United States and China share parallel interests in many areas. It is also true that their goals and approaches naturally diverge in some cases. While Taiwan, arms transfers, and textiles remain areas of disagreement, Washington and Beijing may be able to pursue complementary policies in Korea, Indochina, and other parts of Asia.

U.S. policies toward China are based on the expectation that closer relations can contribute to economic progress in China and peace and stability in Asia.[3] Although rapprochement in the early 1970s was stimulated primarily by the threat of Soviet expansion in Asia, other, more positive, themes of U.S. China policy emerged during the Carter and Reagan Administrations. In addition to counterbalancing the Soviet Union, major goals of U.S. policies include assisting China in its modernization efforts, opening trade opportunities to U.S. firms, and establishing rapport with the next generation of Chinese leaders.

On the surface, these goals complement China's own concerns about Soviet hegemonism in Asia and the PRC's economic modernization aims. In order to modernize its economy, China has instituted sweeping domestic economic reforms to improve economic decisionmaking that also increase local and even individual enterprise. China has also opened the door to foreign participation by setting up special economic zones, enacting a patent law and approving joint ventures, more than 700 in 1984 alone.[4]

But there are also points at which Chinese and U.S. interests seem to diverge, as one would expect for two countries with different economic and political systems. China's policies toward both the United States and the Soviet Union have gone through twists and turns. Taiwan remains a problem in relations with the United States,[5] and some

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[3] See Atlantic Council, *China Policy for the Next Decade* (Washington, DC: 1983), p. 20.

[4] See "China Approved 700 New Joint Ventures in 1984," *China Trade News*, May 1985, p. 3.

[5] See Robert Sutter, "The United States," *Chinese Defense Policy*, Segal and Tow (eds.) (Chicago: University of Illinois Press, 1984), ch. 13.

Association of Southeast Asian Nations (ASEAN) countries friendly to the United States view China's modernization with apprehension. The very success of China's modernization poses new challenges to the U.S.-PRC relationship. Conflict over trade in textiles is a notable example. While Chinese leaders stress their enduring commitment to independence as the cardinal principle in their foreign policy, they have also expressed their view that technical cooperation with the United States has not yet reached the desired level.[6] All the while, China insists that it cannot be "bullied" by foreign countries that hope to force political concessions in exchange for advanced technology.[7] Despite its growing involvement with foreign countries and firms, China continues to value self-reliance.

During the past 6 years, expectations for a widening relationship have run high in the United States. In spite of considerable achievements, translating the general objectives of U.S.-China policy into concrete measures has, at times, proved difficult. U.S. export controls illustrate these difficulties. The United States loosened its controls on exports of dual-use technologies (with military and civilian applications) in 1983 by moving China to category V on the Commodity Control List (CCL).[8] As a result, the process of license review was to be expedited. But, as discussed in more detail in chapter 5, disagreements continue both within the U.S. Government and among Cocom[9] countries about the guidelines for such exports. U.S. exporters and the Chinese as well have complained about delays and uncertainties in U.S. license reviews. U.S. energy technology transfers to China have, nevertheless, grown from an estimated level of $20 to $30 million in 1973-80 to $100 to $125 million in 1980-85.[10]

In the wake of a dramatic transformation in U.S.-China relations during the past few years, the time may be ripe for a more careful definition of areas of mutual and competing interest in relations with China. U.S.-PRC cooperation in energy development is one area where such a reassessment may be particularly timely. Energy problems are a major constraint on China's modernization program, and the energy sector therefore is of strategic importance. The United States has considerable expertise to assist China in developing its energy resources and may make significant gains as a result. In addition to opportunities for benefits, however, there are also risks. Both the long-term opportunities and risks associated with energy technology transfers thus must be evaluated.

LONG-TERM OPPORTUNITIES AND RISKS

Assessments of risks and opportunities associated with energy technology transfers hinge on perspectives concerning trends in Chinese economic development and prospects for U.S.-China relations. During the past 30 years there have been dramatic changes in both areas. Whether Chinese reform policies succeed, China's ability to absorb U.S. technology, and the capabilities of China's own R&D system are some of the questions that influence assessments of opportunities and risks. Such assessments are also contingent on whether China is viewed by the United States as a potential ally, a friendly nonallied nation, an unpredictable neutral country, or a potential enemy.

Opportunities

U.S. policies are today predicated on the notion that the United States has much to gain from transferring energy and other technologies to

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[6] Chen Muhua, State Counselor and Minister of Foreign Relations and Trade, made this statement in "Prospects for Sino-U.S. Economic Relations," *Beijing Review*, No. 17, Apr. 23, 1984.

[7] See Zheng Weizhi, "Independence is the Basic Canon—An Analysis of the Principles of China's Foreign Policy," *Beijing Review*, No. 1, 1985.

[8] In 1980 the United States authorized sales to China on a case-by-case basis of items and technology on the U.S. munitions list.

[9] Cocom (the Coordinating Committee) is the informal multilateral organization through which the United States, Japan, and West European countries control exports of technology and strategic goods to the Communist world.

[10] These estimates are found in Woodard, op. cit., p. 22.

China. Expanded cooperation in the energy sector has been seen as a key avenue for the United States to participate in, and even help shape, China's economic modernization. At the same time, the United States restricts exports of technologies that have significant military applications, such as certain nuclear technologies and very powerful computers.

1. Contribution to Friendly Bilateral Relations

Cooperation in the energy sector is a symbolic as well as a practical demonstration of U.S. expertise and commitment. Because energy development is intimately connected with economic and social change throughout China, it is an area where U.S. influence may be particularly important. Energy, in other words, holds a key to Chinese economic development, and U.S. technology can contribute to the modernization process. The Chinese, furthermore, clearly want U.S. technologies.

Opting out of Chinese energy development would at best disappoint the Chinese and at worst cause serious problems in U.S.-China relations. Other Asian countries could also be affected by such developments. Japan, for example, expanded its relationship with China after U.S.-China relations began to improve. A stable, working U.S.-China relationship is an important element in Japan's own strategic policies.[11] In light of these and other factors, forgoing participation in China's energy development hardly seems a viable alternative for the United States.

2. Trade Opportunities

The China market may not be the bonanza once hoped for, but it is now a significant one, and holds the potential for expanded imports of energy equipment, services, and technologies in the years ahead. In a period of rising U.S. trade deficits, China offers opportunities for expanded exports.[12] Unlike many developing countries, China has a foreign exchange surplus, and although the surplus is diminishing, China is still able to pay for its imports.

In fact, China is making significant strides in developing its energy resources and will undoubtedly continue to do so with or without U.S. help. In most cases Japan and West European countries can supply similar energy exploration and production equipment, services, and technology if U.S. firms do not. U.S. technology is apparently highly regarded by the Chinese, but U.S. firms compete for contracts with other suppliers such as Japanese firms that have considerable experience in the China market and official financing support. In some cases, such as hydropower projects, the availability of supplier government financing can be a key factor in selection of foreign participation.

3. Potential Geopolitical Gains

There are also geopolitical benefits from closer U.S.-PRC cooperation in energy. In an earlier period, China cooperated with the nations of the Soviet bloc in energy, and conceivably could do so again if its technological needs cannot be met by the West. For instance, China and the U.S.S.R. have discussed the sale of nuclear powerplants to China. While such sales need not compromise U.S. interests, it may be more in the U.S. interest to reinforce the trends of the last decade toward fuller Chinese involvement in the Western energy system.

4. Asian Energy Supplies

If China is successful in developing its energy resources, it can also make a contribution to regional energy supply stability. The availability of Chinese energy resources to other nations in the region could provide greater assurance of supplies for energy-poor countries in the Pacific, and would offer an opportunity for these countries to diversify their supplies. China's ability to meet more of *its* requirements with domestic resources would also lessen its competition with the energy-poor nations for regional energy resources.

5. Technical Exchange

Finally, as a people-to-people process, technology transfer provides avenues for mutually enriching cross-cultural exchanges. As Chinese technicians visit U.S. laboratories, assembly lines, and libraries and as U.S. professionals travel to China, they have the opportunity to form long-lasting relationships that forge ties between representatives of this core industry in the two countries. U.S. firms and organizations involved in Chinese energy development have the opportunity to help China shape its economic future, and possibly further improve their technology and perfect their expertise in international technology transfers.

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[11] See Denis Simon, Background Paper V, "Energy Technology Transfer to China: The Downside Risks," prepared for the Office of Technology Assessment, May 17, 1985, p. 28.

[12] In 1984 U.S.-China trade was in balance, with exports from the United States of $3.4 billion and imports to the United States of $3.3 billion (official Department of Commerce statistics, July 1985).

Risks

The United States stands to gain much in energy technology transfers to China if these potential opportunities are realized, but there are also certain risks or uncertainties that pertain to national security as well commerce that must be considered.

1. Diversions to Military Applications

The ultimate risk is that a future China that may be hostile to the United States would benefit militarily as well as economically from certain energy-related technologies transferred by the United States today. Concerns for Chinese military benefits are associated with the transfer of "dual-use" technologies (some of the seismic, calibration, and computer technologies used in energy development) and aspects of nuclear technology (discussed separately in a later section).

China's current leadership appears committed to domestic economic reform and to opening itself to foreign investment. China has stated that it values cooperation with the United States as part of this process. It is, however, difficult if not impossible to predict policy shifts that might occur a decade in the future. U.S. policymakers must therefore take into account the possibility that dramatic shifts could occur, since under such circumstances we could regret the dual-use transfers we make today.

We know enough about the organization of Chinese R&D, and China's considerable science and technology capabilities, not to be/careless about dual-use transfers. Some Chinese scientists and engineers who have studied in the United States will return to serve in China's military or their know-how will benefit military development indirectly. Over the long run, it is impossible to "compartmentalize" technologies in terms of their impacts on an economy.

In the near term, however, there are a number of factors that limit the military risks associated with civilian energy technology transfers to China. Many energy technology transfers do not include sensitive dual-use items, and therefore do not directly pose problems for U.S. national security. China's ability to apply such technologies is also limited by the slow pace of Chinese military modernization. In the intermediate term, however, China will be able to absorb increasingly sophisticated dual-use technologies. Therefore, if economic modernization proceeds apace, over the longer term China's growing technological expertise can be expected to make significant contributions to its military.

In theory, the U.S. export control system provides a mechanism for constraining the transfer of sensitive technologies. The United States can and does attach conditions on the transfer of dual-use equipment (leasing, operation by U.S. citizens) that limit the diffusion of sensitive technologies to the military sector. Such controls are costly, not welcomed by the Chinese, and certainly do not completely rule out the possibility of diversions. China can also obtain (and reportedly has in some instances) U.S.-manufactured dual-use technologies in Hong Kong and third countries.

Another possibility is that dual-use technologies transferred to China might fall into the hands of unfriendly countries. But China today has little incentive to transfer sensitive technologies to countries such as Vietnam or the U.S.S.R. because doing so would create security problems on its own borders. In addition, U.S. firms set limits on retransfers through written contracts (which the Chinese seem to honor) and through their option to forgo further transfers if violations occur. In the case of nuclear technology, there are special problems (discussed below) surrounding retransfers to third countries related to the potential spread of nuclear weapons.

2. Geopolitical Risks

If China succeeds in modernizing its economy through the application of imported technology and other means, it will be in a position to play an increasingly important role in Asian politics and markets. Some observers in ASEAN countries, as well as Taiwan and other Asian countries, view this prospect with concern. A vibrant China could exert considerable influence through nonmilitary means on its neighbors. In light of traditional animosities and current military conflict between China and some countries such as Vietnam, there is a legitimate concern that China's emergence as a regional and even global power could create new and aggravate old conflicts in Asia.

There is also a potential for regional conflict in Asia as China develops its energy resources. Territorial disputes have impinged on offshore oil and gas development. There have been reports that the U.S. firms ARCO and Pennzoil exploring for oil in the South China Sea have been harrassed by Vietnamese gunboats.[13] While conflicting territorial claims may not be sufficient to *provoke* military conflict, political and military disputes between China and Vietnam, for example, may be played out in a struggle over potentially energy-rich territories.[14]

Particularly relevant from the U.S. perspective is the fact that private companies participating in joint ventures in China incur investment risks. These firms could suffer financially if China were to scale back its development plans (as it did a few years ago). U.S. firms involved in China's offshore oil and gas development have made large preliminary investments, indicating considerable financial risks, but such investment risks are primarily the concern of the firms. The U.S. Government, however, insures some U.S. firms investing in China against political risks through the Overseas Private Investment Corporation. The U.S. Government also provides information to U.S. investors concerning domestic political and economic developments in China.

3. China Trade Competition and the Alliance

The United States has commercial interests at stake in energy technology transfers to China. China is both a significant market and potential competitor. Today, competition among suppliers for shares of the China market poses more immediate and significant U.S. policy issues than does China's growing role as an exporter of energy-related commodities, equipment, and services.

As firms from many countries compete for sales in China, supplier governments may be tempted to provide extraordinary support for domestic firms, through financing, aid programs, and representation of business in negotiations. This can also happen when Cocom members attempt to manipulate the process to the benefit of their own domestic firms. While there is room for legitimate disagreement in many instances about whether or not such government actions provide "unfair" advantages, the result is to raise the stakes of supplier competition.

From the U.S. perspective, these problems are reflected in debates about Export-Import Bank financing, U.S. approaches to Cocom, and U.S. export controls. At stake here, among other things, is the capability of U.S. firms to compete for sales in the China market.

4. The Terms of Technology Transfer—Intellectual Property

As U.S. firms transfer energy technology to China there is the potential risk that technology developed in the United States may be appropriated without adequate compensation to the originator. China's recent enactment of a patent law and recent promulgation of technology transfer regulations, however, are positive signs of its intent to honor technology transfer agreements. The law, however, does not cover software and certain chemical processes, and it is not yet clear how China will implement the new legislation.

5. China as an Economic Competitor

It does not appear likely that Chinese energy-related exports will seriously compete with those from the United States. There is no energy technology or equipment area in which China will be a significant exporter in the near term. China, however, is selling small-scale hydropower technology and may be exporting some energy equipment after 1995. In the next century China could emerge as an exporter of large reactors and coal conversion technologies, but this is only conjecture. More likely, China's ability to satisfy its energy demand through the use of U.S. technology will enhance the performance of its economy generally, and the export sector in particular. The possibility of China becoming a competitor in certain industries such as consumer electronics is no longer far-fetched.

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[13] See House Committee on Energy and Commerce, Special Subcommittee on U.S. Trade with China, *China's Economic Development and U.S. Trade Interests*, report, May 1985, p. 16.

[14] See, in particular, Selig S. Harrison, *China, Oil and Asia: Conflict Ahead?* (New York: Columbia University Press, 1977), for a discussion of the potential for conflict over disputed offshore territories between China and neighbor countries such as Vietnam.

China is already an actor in Asian energy trade, and may become a major energy exporter during the next decade. Chinese oil exports can help to offset the dependence on OPEC of some countries like Japan. At the same time, China will certainly compete with other countries in Asian energy markets. To cite one example, both China and the United States want to sell coal to Japan. Japan is helping China develop its coal resources and has long-term coal and oil supply agreements with China. While China has not met its targets for coal exports to date, its coal exports will jump if just one of the major coal development projects is completed. To cite another example, China is already exporting more than 500,000 barrels per day of oil and may increase exports significantly during the next decade.[15] Indonesia's oil industry sees itself as competing with China in oil sales to Japan.

No importer of Chinese energy, Japan included, is likely to become dangerously "dependent."[16] But there are regional dimensions to China's emergence as an energy exporter. Chinese energy development may not seriously jeopardize energy development in other Asian countries, but it will certainly compete for investment capital and other resources. A major area of uncertainty is China's future role in regional markets and institutions,[17] the nature of its integration into the Pacific Basin.

The logical outcome of technology transfers is that China will more efficiently produce energy, equipment, and services for both its internal market and for export. Some U.S. firms may find that sale of proprietary technology through licensing and patents is their only avenue for participating in the China's energy development. More commonly, the U.S. firms that transfer energy technology also sell equipment and technical services. Over the long run, U.S. firms that transfer energy technologies will need to further develop these and other technologies in order to remain competitive.

6. U.S. Policymaking Inadequacies

There are also potential risks stemming from the U.S. policymaking process itself. Each high-level U.S. Government mission is challenged to bring back tangible evidence of success in the form of new protocols and agreements. At the same time, disputes among various parts of the U.S. Government (and even within departments) reflect the absence of a clear U.S. strategy on export controls. The danger is that as U.S. policies concerning technology transfer are built on a case-by-case basis, we may lose sight of overall U.S. goals. Furthermore, there is evidence that U.S. policy *declarations* raise Chinese expectations which are then dashed at the policy implementation stage.

7. Technology Transfer Failures

Although there are risks associated with participating in China's energy development (including the possibility that the United States might be blamed for projects that fail), the risks to the United States could be even more significant if China fails to meet its energy development goals. An economically stagnant China could see domestic political instability and might play a hostile role in the Asian region. Foreign technology may not be *the* key variable in China's energy equation, but foreign assistance could significantly help China to meet its goals.

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[15] See Fereidun Fesharaki, et al., *Critical Energy Issues in Asia and the Pacific* (Boulder, CO: Westview Press, 1982), p. 36, for a forecast that China will be exporting 500,000 to 1.5 million barrels per day of petroleum by 1990.

[16] Japan imported 4.4 percent of its total coal imports and 5.2 percent of its crude oil and refined products from China in 1983. See Richard K. Nanto and Hong Nack Kim, "Sino-Japanese Relations," CRS Paper, November 1984. For a detailed projection of Chinese energy production, see Kim Woodard, "Development of China's Petroleum Industry," prepared for East-West Center Workshop on China Energy, Apr. 25-26, 1985. Woodard concludes that it will be difficult for China to sustain the current level of crude and product exports through the end of the decade, let alone increase exports by significant margins.

[17] The Asian Development Bank has not admitted China, but the issue is under debate.

The gains associated with energy technology transfers appear clear and compelling, as discussed above. In contrast, the risks are in some instances vague and uncertain, particularly over the long term. But while the gains outweigh the risks associated with transferring U.S. energy technology to China, there are significant risks to be managed. These include the risk that the dual-use technologies (including nuclear) that the United States transfers to China could be used in ways that pose security problems for the United States. Intense competition among supplier firms and governments to outdo one another in financing also involves risks to the U.S. Government. Uncertainties associated with China's entry into Asian energy trade also pose challenges to U.S. policies.

TECHNOLOGY AS A TOOL OF U.S. FOREIGN POLICY

Science and technology have already been used as tools of U.S.-China policy. Since the Carter Administration, science and technology have been highlighted in U.S.-China relations. There has, however, been no explicit or coherent strategy for the use of technology as a tool in U.S. policies toward China.

Identifying the instances where technology has been an important instrument for U.S. policies toward China could be a first step in improving policies. In the face of the opportunities and risks discussed above, the question now is how technology can be used more effectively as a tool of foreign policy.

The ability of the U.S. Government to extract political or other concessions from China by denying sales of U.S. energy technologies is quite limited, even where U.S. firms hold a technological lead (oil and gas exploration, for example). This is because Japan and West European countries are ready and eager alternative suppliers, and U.S. technological leads (where present) in energy technologies are not so great that other suppliers cannot compete.

Sequencing (gradual expansion of trade in technology as bilateral relations improve and experience deepens) is another approach that might be effective if pursued systematically. In some cases, sensitive dual-use technologies may make up only a minor portion of the dollar value of an energy development project, but these technologies can be absolutely critical to the project. Under the export administration system, decisions to loosen restrictions on export of the more sensitive energy technologies are made within the executive branch, and have oftentimes been controversial. Interagency reviews and low key dialog with Chinese end-users to check the strength of their commitments to abide by U.S. stipulations, if properly pursued, can ensure that risks associated with dual-use transfers have been taken into account and steps taken to minimize them. But, in practice, disagreements within and between various branches of the U.S. Government (and within Cocom) have precluded the systematic implementation of a technology sequencing strategy.

Most of the technologies that China seeks to develop its energy resources are not sensitive dual-use technologies. In these areas, technology transfers could serve U.S. interests by contributing to China's energy development and economic modernization. Private sector U.S. firms are the locus of this technology, and they have generally been willing to provide it independently of any U.S. Government programs. But some of the technology that China needs is not being provided because U.S. suppliers are not informed about these needs or because they do not see these as attractive business opportunities. Efforts by the U.S. Government to further encourage private sector participation in Chinese energy development would be viewed positively by the Chinese and probably contribute to friendly relations. Technical and management training programs supported by the U.S. Government, such as the one in Dalian, are another avenue for positive participation.

Among the primary explanations for the difficulty of using technology as a finely tuned instrument of U.S. foreign policy is the fact that the private sector rather than the U.S. Government is the holder of the technology. Export controls, the major mechanism for controlling the international flow of technology, have been used to limit certain kinds of U.S. trade with China. But technical exchange and technology transfer are less susceptible to such regulations. The Government's ability to manipulate technology transfer to serve foreign policy goals in particular cases is often quite limited. However, conditional access to technology has been used as an element of U.S. policies toward other developing countries when a strong consensus exists on a U.S. policy goal (such as nuclear nonproliferation) and when other suppliers have been willing to cooperate.

Our ability to use technology as an instrument of foreign policy is often dependent on how technology is "packaged" with other enabling resources. In the energy area, financing is a particularly important example of the latter. Energy development in China is a mammoth and extremely costly undertaking. Helping to finance the costs of this development may be necessary if the full benefits of technology in foreign policy are to be realized.

Over the long term, technology can be an important asset to U.S. China policies, but perhaps not a finely honed tool. Government-to-government science and technology cooperation agreements, for example, set the stage for technology transfers by private sector firms. But it is virtually impossible to isolate the effects of such government policies and programs on China's energy development. In this sense, the transfer of U.S. energy technologies to China generally supports (and derives from) increasingly friendly bilateral relations. While the U.S. Government is not directly involved in most of these transfers, its policies are nevertheless critical because they set the parameters for U.S. technology transfer.

Chapter 3

Energy Technology Transfers

Chapter 3

Energy Technology Transfers

China's present energy shortages appear inconsistent with its vast and varied energy resource base. Some of the shortages can be alleviated by expanding present capabilities, for instance opening more coal mines, but much of the resource base will be unavailable without improved technology. Sophisticated techniques are required to explore for oil and gas offshore or in remote regions. Coal is plentiful, but bottlenecks prevent enough from reaching the market, and the environmental impacts of burning large quantities are severe in some areas. The best potential hydroelectric sites are far from load centers, requiring long-distance, high-voltage transmission systems. Nuclear energy, known to the Chinese through their military programs, requires a quite different approach for power generation. Energy can also be used much more efficiently.

While China may be capable of developing these technologies indigenously, the process can be speeded considerably and made more efficient by the importation of foreign technology. Much already has been imported, and the Chinese have an intense interest in expanding this access.

This chapter reviews the resources available to China and present trends in energy production and consumption. Then the role that technology, both domestic and foreign, might play is evaluated in light of constraints on the Chinese system. Further detail, and the basis of much of this discussion can be found in the background paper "Technology Transfer and China's Energy Industries."

RESOURCES

Reliable data for China's oil and gas reserves are not available, but much can be pieced together. Most exploration has taken place in the northeast corridor, and that is where the giant fields and 75 percent of the reserves are located. Proved and probable reserves in the northeast are estimated at 10 to 15 billion barrels.[1] Cumulative production has been 10 billion barrels, and additional discoveries and advanced technology may add an equivalent amount of oil resources.

Petroleum reserves in the western part of the country are much less certain because exploration has been much less intense. Perhaps 3 to 5 billion barrels will be produced there. Offshore reserves are even more speculative because extensive exploration began relatively recently, and much of the exploration has been disappointing. Offshore reserves of 20 to 30 billion barrels are a commonly accepted projection. Thus the ultimately recoverable petroleum reserves are 50 to 70 billion barrels. China's proved reserves are less than those of the United States though the potential for further discoveries is greater.

Known natural gas reserves are only 4.6 trillion cubic feet, a much lower energy resource than crude oil reserves. However, gas has been a lower priority fuel because it is difficult to transport without an expensive pipeline system, and there is little export market. However, recent offshore drilling in the South China Sea has resulted in a commercially exploitable find in the range of 3 to 7 trillion cubic feet. Basins in western China also show promise of very significant gas resources. These finds may stimulate interest in building the required infrastructure and searching for more gas.

Coal deposits are gigantic, over 750 billion tons,[2] and may be double that. Actual recoverable reserves are much lower, but China is in the same class with the United States or the U.S.S.R., which have the largest in the world. At the present rate of exploitation, this coal would last hundreds of years. Most of it is reasonably good quality bituminous grade. Pockets of coal occur practically everywhere in the country, but the major seams are in the central and north central regions, far from the major industrial regions near the coast.

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[1] See Kim Woodard, Background Paper I, "Technology Transfer and China's Energy Industries," prepared for the Office of Technology Assessment, Apr. 18, 1985.

[2] China Energy Ventures, Inc., unpublished data, April 1985.

Hydropower resources are also huge, potentially as much as 380,000 megawatts (MW).[3] Only 22,000 MW have been exploited. About 60 percent of the potential is in the Southwest, a great distance from population centers.

Figure 1 shows the location of the major energy resources.

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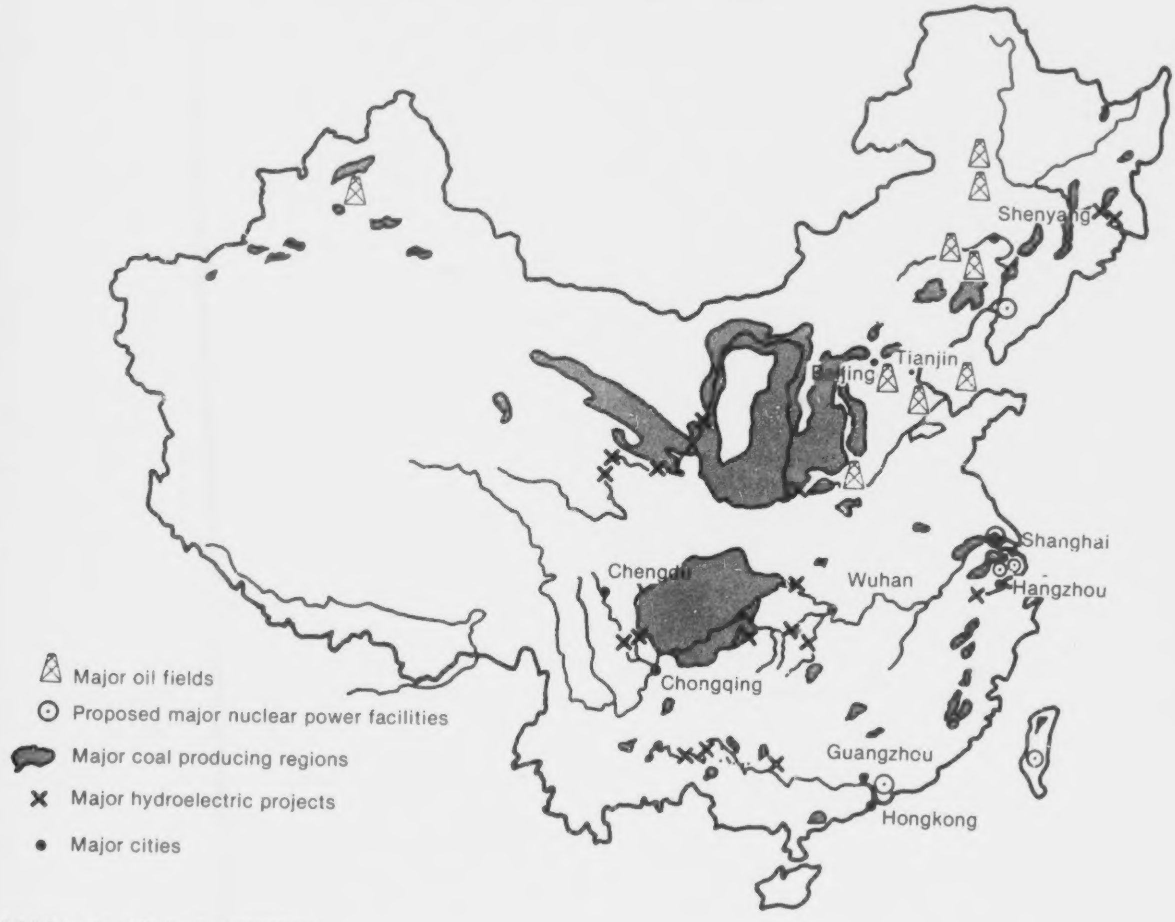
[3] Ibid.

Figure 1.—China's Energy Resources


Shenyang
Beijing
Tianjin
Shanghai
Chengdu
Wuhan
Hangzhou
Chongqing
Guangzhou
Hongkong
Major oil fields
Proposed major nuclear power facilities
Major coal producing regions
Major hydroelectric projects
Major cities

SOURCE: Office of Technology Assessment.

TRENDS IN ENERGY PRODUCTION AND USE

Petroleum

Crude oil production rose rapidly in the 1970s to over 2 million barrels per day in 1979 (the United States produces 8.6 million). By 1980, however, production flattened out due to the maturing of the biggest fields and a rapid decline in one unusual formation. Output in most fields has now stabilized or is increasing slightly, but at the expense of ever-increasing water injection to maintain pressure. Production data are shown in table 1. The fields that are mature now are expected to decline in a few years.

This situation has developed largely because of a lack of exploration. The fields in the northeast appeared to be so large that little attention was paid to the rate of depletion and the need to develop new fields. Even now that the situation has been recognized, China is spending only about $2 to $3 billion on oil exploration and development, about what a moderate size U.S. company would invest for a tiny fraction of China's production. In effect, China has been producing itself out of business.

This has led to an extensive reevaluation of petroleum policies in China. The Ministry of Petroleum Industry has shifted from "self-reliance" and is allowing foreign oil companies to participate in offshore exploration. More recently, as the focus of exploration has shifted to the northwest, which has a huge potential but harsh conditions, China has sought help from foreign companies in seismic surveys and exploratory drilling. Foreign oil companies may be invited to participate in exploration and production activities in 10 provinces south of the Yangtze River under arrangements similar to the offshore concessions.

Natural Gas

Natural gas production is limited to one basin in Sichuan and as a byproduct at the major oilfields. Production has been declining significantly as shown in table 2, largely because of a severe

Table 1.—Petroleum Production by Region (thousand barrels/day)

Region	Year 1970	1978	1980	1982	1983	1984
Northeast	447.4	1,120.8	1,171.8	1,163.8	1,181.0	1,235.2
North	20.4	408.0	382.2	285.4	270.2	268.8
East	93.4	395.0	358.4	380.6	434.8	547.2
Northwest	45.8	98.8	121.2	124.0	135.4	141.4
Central-South	5.4	56.6	83.2	84.4	96.0	96.0
Southwest	0.6	21.8	2.0	2.0	2.0	2.0
Total	613.0	2,101.0	2,118.8	2,040.2	2,119.4	2,290.6

SOURCE: China Energy Ventures, Inc.

Table 2.—Natural Gas Production by Region (trillion cubic feet)

Region	Year 1977	1978	1979	1980	1981	1982	1983
Northeast	0.169	0.183	0.189	0.193	0.157		
North	0.028	0.030	0.034	0.029	0.026		
East	0.043	0.053	0.057	0.053	0.044		
Central-South	0.001	0.001	0.001	0.002	0.002		
Northwest	0.009	0.011	0.012	0.014	0.016		
Sichuan	0.192	0.224	0.238	0.231	0.212	0.191	
Total[a]	0.442	0.501	0.530	0.521	0.456	0.434	0.419

[a] Totals may not add due to rounding.

SOURCE: Ministry of Petroleum.

undercapitalization (especially in exploration) and a failure to acquire modern technology comparable to the oil industry. There are few gas pipelines in the country to get the gas to market even if production can be increased. The gas discovered by ARCO in the South China Sea might be converted to fertilizer at coastal plants.

Coal

Currently, coal represents 74 percent of China's energy production. While the share is dropping, actual production has risen fairly steadily at an annual rate of 7 to 8 percent as shown in table 3. Future production will be a function of the level of investment in mines, other facilities, and transportation infrastructure. The stated target for 2000 is 1.2 billion tons, about double the rate in 1980. Almost half of this goal would be met by small, local mines, but annual additions to large mine capacity will have to be 10 to 12 million tons per year. The mine at Pingshuo in Shanxi Province, to be developed by the Island Creek Coal Co. (a division of Occidental Petroleum), will have a capacity of 15 million tons per year. At present, almost all mining is underground, but some of the biggest new mines will be surface mines. Operations at most coal mines are inefficient. On the average, less than a ton is produced per man-day, versus about 10 tons for underground mines in the United States.

Very little coal (about 10 percent of output) is cleaned before shipment. In many mines, noncombustible matter significantly increases shipping costs and causes problems in boilers when the coal is burned. It is likely that beneficiation (coal cleaning) plants will become more common, but progress has been slow.

Transportation is a major bottleneck. Coal already represents about 40 percent of all rail shipments. Many lines are being upgraded, but the process is slow and expensive. China intends to export more coal, which will depend on ports being upgraded in addition to the lines to the ports. Japan is a natural market for Chinese coal and is financing mine and port development, but the slumping price of coal on the world market has reduced the incentive to make these improvements.

Table 3.—Coal Production (million metric tons)

1970	353.9
1978	617.9
1980	620.1
1981	621.6
1982	666.0
1983	692.0
1984	772.0

SOURCE: China Energy Ventures, Inc., and National Council for U.S.-China Trade.

Electricity

The electric power industry has been growing rapidly as shown in table 4. Present total capacity is 81,000 MW, of which 68 percent is from steam plants (mostly coal) and the rest is hydropower. There are six major regional grids and many small local grids. Twenty-two long-distance, high-voltage transmission lines have been built.[4] Others have been announced, including a 1,300 kilometer direct current line from Qinghai to Hebei.

Despite the growth, there is a severe shortage of electricity. It is estimated that only about 80 percent of the nation's industrial capacity can be operated at any one time because of inadequate electric capacity.[5] The current shortfall is about 10,000 MW. At peak consumption hours, some customers are cut off or restricted. In addition to lost production, blackouts can damage equipment.

There are 18 large hydropower stations and another 11 under construction for completion by 1990. The largest potential project, the "Three Gorges" on the Yangtze River, could produce 12,000 MW, but it is still in the planning phase. This project, estimated at $9 to $12 billion, would

Table 4.—Electric Power Production (billion kWh)

	Thermal	Hydro	Total
1970	95.4	20.5	115.9
1978	212.0	44.6	256.6
1980	242.4	58.2	300.6
1981	243.8	65.5	309.3
1982	253.3	74.4	327.7
1983	263.5	84.5	348.0
1984	289.1	85.5	374.6

SOURCE: China Energy Ventures, Inc., and National Council for U.S.-China Trade.

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[4] Fujiko Kitani, "Electric Power in China," *China Newsletter*, No. 56, JETRO.

[5] Lu Qi, "Energy Conservation and Its Prospects," *Beijing Review*, No. 46, November 1984.

rank among the world's largest construction projects. Figure 1 shows some of the major hydropower sites. There are also over 100 midsized (12 to 250 MW) hydropower stations. China is the world leader in the development of mini-hydro plants, with over 80,000. This represents over one-third of all hydropower capacity, and is an important part of the rural electrification strategy.

There are about 65 large thermal plants in the country, mostly in industrial areas. Thermal power will represent the bulk of additions to the electric power system for the foreseeable future. The plants are mostly indigenously built, and they are significantly less efficient (28 percent) than new U.S. coal plants (about 40 percent). Powerplants consume over 15 percent of petroleum supplies, which is a significant loss of potential exports or alternative use in the economy.

Projections

Estimated primary energy production through 2000 is shown in table 5. These projections are based on a computer simulation done in early 1984 and are included for illustrative purposes only. Actual 1984 production for coal was 772 million metric tons and for petroleum, 114 million metric tons.

Energy Use

China uses all of the energy production discussed above except for the export of about 500,000 to 600,000 barrels per day of oil (including refined products) and 7 million tons of coal per year. Much of this use is quite inefficient. Artificially low energy prices and a shortage of capital have resulted in a vast amount of equipment and processes that was not designed to minimize energy use. It is now clear that demand for energy services will increase rapidly as the economy and standards of living rise, but that producing great amounts of additional energy will be very expensive, polluting, and in some cases, impossible. Therefore, to meet economic goals, increasing the efficiency of energy use will be necessary.

In the 1970s, China launched a major program to increase efficiency and conserve energy, a significant departure from past practices. This program has had considerable success, saving the equivalent of several tens of million tons of coal each year (cumulative). Further conservation will require increasing investment as the easy measures are taken, but it is likely that saving energy will be at least cost competitive with producing energy for many years.

In the industrial sector (which uses 72 percent of China's total primary energy), only about 40 percent of the energy is converted to useful service.[6] Improving this record would have a double benefit: reducing the cost of production and freeing the energy for other purposes. Prioritization of energy allocation is an important inducement. The most efficient plants are assured a supply of energy, while the least efficient ones are closed in times of shortages. Not only does this mean the most efficient plants operate the longest, but it provides incentives for plant managers to fix their problems. Fuel switching from oil to coal is also encouraged to reduce energy costs, especially in facilities that changed from coal to oil in the 1960s and 1970s. So far, however, conversion has been slow, as it has been in the United States. Improved energy management is another priority, using audits, energy measurement instruments, and analysis to identify conservation opportunities. Old equipment and plants are being renovated (e.g., with insulation or air preheaters) or even replaced to achieve large savings. Cogeneration and residual heat recovery are being emphasized. The recent emphasis on light industry is also helping slow the growth rate of energy demand.

The commercial/residential sector used only 14 percent of China's total commercial energy.[7] Coal is the major fuel for cooking and heating. In rural areas, noncommercial fuels (wood, crop byproducts, biogas) are very important, but it is possible that this dependence will drop as incomes rise and more convenient fuels become available. In any event, neither technology nor equipment is likely to be exported by the United States. One-third of the peasants have no electricity.[8] It is a national goal to electrify all rural villages by 2000.

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[6] "Energy Conservation," *The China Business Review*, January-February 1982, p. 12.

[7] Ibid., p. 18.

[8] Qi, op. cit., p. 20.

Table 5.—Projected Primary Energy Production[a]

Year	Coal		Crude petroleum		Natural gas		Hydropower		Total energy	
	Baseline (mmt)	Plan (mmt)	Baseline (mmt)	Plan (mmt)	Baseline (bcm)	High (bcm)	Baseline (bkWh)	Plan (bkWh)	Baseline (mmtce)	Plan (mmtce)
1975	(484)		(77)		(9)		(47)		(472)	
1980	(620)		(106)		(14)		(58)		(620)	
1983	(692)		(106)		(12)		(84)		(671)	
1985	743	700	109	117	12	14	95	100	713	698
1990	821	850	115	132	12	19	123	140	771	838
1995	895	1,000	122	156	16	27	175	210	847	999
2000	966	1,200	131	210	21	38	228	300	924	1,245

[a] These projections are based on a computer simulation done in early 1984 and are included for illustrative purposes only. Actual 1984 production for coal was 772 mmt and for petroleum, 114 mmt.

SOURCE: China Energy Ventures, Inc.

In the transportation sector, demand for liquid fuels is expected to rise rapidly. Railroads are being electrified, but the increasing number of diesel locomotives, automobiles, airplanes, trucks, and buses will put considerable pressure on the oil industry. The Ministry of Transportation is retrofitting most of the older engines in its trucks, in large part to reduce fuel consumption. This one step is estimated to save 60,000 barrels of fuel per year.[9]

TRENDS IN ENERGY TECHNOLOGY TRANSFER

Technology acquisition has been a central feature of China's energy programs for many years, but until 1980, direct sales of equipment and even entire factories were far more important than technology transfer. In some cases, China tried reverse engineering (reproducing a finished product without access to design and manufacturing information, such as was done with oilfield equipment). Many of these efforts were not very successful though some products are being used. The Chinese petroleum industry, at least, has decided it is less costly and more effective in the long run to procure technology directly.

Petroleum Exploration and Production

The offshore oil exploration projects have stimulated petroleum technology transfers, including training, joint technical services, and joint management. Many of the smaller U.S. oilfield service companies are now participating. Contracts for licensing to manufacture equipment have been rare for offshore technology production, largely because the market is limited (only 19 rigs were active in 1984, and this number will not grow in the next year or two).

The situation is reversed onshore, where foreign participation has been limited to specialized services and equipment supply. Onshore activity is much greater, with about 800 to 900 active rigs. All of China's production has been onshore. Licensing arrangements have been more attractive than for offshore technology, especially as a way of gaining access to the market. The prime example is the drill bit factory established under a licensing contract by the Hughes Tool Co. Hughes was paid a fee for the transfer and still receives royalties for the production. In addition, it is allowed to sell large quantities of U.S.-made drill bits in China because far more are needed than the factory can supply (although some appear to have been exported).

The total commercial value of technology transfer and training programs in the 1980-85 period is estimated to be $100 to $125 million. While this may appear small compared to the $1 billion spent by foreign companies for exploration offshore, or the $250 million imports of equipment and services for the onshore market in 1984 alone, the technology transfer component has major long-term implications. Furthermore, contracts signed but not yet implemented are not included, and there are many contracts being negotiated, a long-term process itself. Estimated values for the next 5 years are $500 to $900 million, as shown in table 6. Key items are likely to be:

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[9] "Refit Gives More Power to Old Trucks," *China Daily*, Mar. 14, 1985, p. 2.

- advanced geophysical technology such as seismic equipment and computer hardware and software;
- manufacturing technology for land drilling rigs, downhole completion equipment, and pressure control equipment;
- steam injection and enhanced recovery technology; and
- instrumentation.

U.S. companies will be in a strong position to compete for this business (which may diminish in the 1990s as the Chinese increasingly master the technologies). The Chinese are also particularly interested in technology to meet materials requirements for the manufacturing capabilities they are purchasing, such as high-grade metallurgy, specialized rubber, and other elastomers. It should be noted that all these basic materials technologies have military as well as energy applications.

Petroleum Refining and Petrochemicals

China is a net exporter of refined petroleum products, including $300 million of gasoline to the United States in 1984.[10] The need to earn additional foreign exchange (which is crucial to the purchase of more foreign technology to continue the modernization program) is a strong motivation for accelerated technology acquisition to improve refineries. Import substitution is the motivation in the case of petrochemicals and fertilizer. China spends about $2 billion annually in foreign exchange on these items.

Licenses for chemical processes are now increasing because SINOPEC, the corporation with control over China's refineries and related facilities is engaged in a $3 billion refinery modernization program. If production of offshore oil starts, construction of coastal refineries is likely, possibly under joint management or even as joint ventures. The worldwide glut of refining capacity argues against any near-term construction of much additional capacity, however. License agreements have been signed for the manufacture of various pieces of equipment for chemical plants, but the combined value of the licenses is probably only about $5 million.[11] Specific technologies of interest include:

- secondary refining technology, such as hydrocrackers;
- process licenses for specialized petroleum products, pesticides and agricultural chemicals, and synthetic materials such as elastomers; and
- engineering and construction technology for plant design and pipelines.

U.S. companies have a long record of involvement in this area of the Chinese market. They are likely to make significant sales, perhaps $50 to $100 million over the next 5 years, not including sales of equipment.

Table 6.—Estimated Values of U.S. Technology Transfer to China[a]

	1973-80	1980-85	1986-90
Petroleum exploration and production	marginal	$60-70 million	$300-500 million
Refining and petrochemicals	$15-20 million	$15-20 million	$ 50-100 million
Coal	marginal	$10-15 million	$ 50-100 million
Electric power	marginal	$20-25 million	$100-200 million
Total	$20-30 million	$100-125 million	$500-900 million

[a] Estimated values; do not necessarily total. Includes only money actually spent by China or its foreign companies on technology transfer and training during periods in question.

SOURCE: China Energy Ventures, Inc.

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[10] This may drop to zero next year because the phasing out of lead in U.S. gasoline makes the low octane Chinese gasoline useless even for blending. The Chinese are likely to resent the loss of a major market.

[11] Woodard, op. cit., p. 16.

Coal Mining and Transportation

China produces almost as much coal as the United States, but its coal mining technology continues to lag. U.S. companies are becoming involved in every level of the Chinese coal industry including large mine development, engineering contracts for mines and transportation, and licenses for mining and beneficiation equipment.

U.S. technology transfer for coal development has generally lagged behind that for oil, despite the considerably greater importance of coal in China's energy system. This is because coal exports create relatively small foreign exchange earnings ($500 million in 1984, or 10 percent of the earnings from oil exports) and because coal technology is not as esoteric. Another reason for delays in coal technology transfer is that the mimes that will be opened by U.S. companies are the subject of protracted negotiations, as is much of the foreign investment in China.

Meeting the goal of 1.2 billion tons of coal by 2000 will require an expansion of capacity of about 50 percent or about 30 million tons per year. On the average, at least one very large mine, several medium-sized ones and a lot of small local mines must be added each year, as well as a vast infrastructure of beneficiation plants, transportation systems and port facilities. Technologies that are already being imported or discussed include:

- engineering for large open-pit mines;
- slurry pipelines and unit trains;
- mine safety technology;
- manufacturing licenses for equipment; and
- beneficiation technology.

U.S. companies have an edge on surface mining and short wall underground mining equipment and beneficiation plants. Most long wall mining equipment is still made in Europe. Total value of technology transfer from the United States over the next 5 years may be $50 to $100 million.

Electric Power

U.S. technology transfer in the electric sector has been concentrated in a few large contracts for modern generator and boiler technology. These licensing contracts are intended to improve the efficiency and increase the size (from 250 to as much as 600 MW) of China's standard generating plant. China has also begun importing electric transmission technology from U.S. firms, and this is likely to increase as the voltage of the lines increases. Important technologies are likely to include:

- boiler retrofits and other thermal efficiency technology;
- design and engineering technology for large powerplants and particularly for hydropower stations (and also tidal powerplants);
- high-voltage transmission and switchgear and control systems; and
- pollution control equipment.

U.S. companies will be competitive in these markets. Total value could be $100 to $200 million from 1986 to 1990. Nuclear power technology is also a possibility that is covered in the next chapter of this technical memorandum.

Conservation

Technologies to improve the efficiency of energy use can be sold in their own right or as part of a larger package, such as a steel mill, a powerplant, or an oil refinery. The largest gain in efficiency comes when a completely new plant is built, incorporating the best of modern technology. This is also a very capital-intensive approach which normally cannot be justified simply on the grounds of energy efficiency. As demand for production increases, however, new manufacturing facilities will be required, and average efficiency will improve, but most gains in the near-term will come from retrofits. China's program to increase efficiency has had considerable success, but after the easy housekeeping measures (simple insulation, adjusting combustion conditions, cleaning steam traps, etc.), identifying opportunities and implementing solutions becomes much more difficult and costly. This next stage of energy conservation may provide many opportunities for the sale of equipment and the transfer of technologies. Some of the technologies are:

- monitoring equipment;
- air preheaters and heat recuperators;
- process controls;

- cogeneration equipment;
- high efficiency motors and pumps;
- energy management techniques and systems, including instrumentation and control equipment;
- energy auditing techniques and analysis; and
- high efficiency lighting.

No estimate is available for the potential value of such technology transfer because it covers such a wide range, and each sale might be relatively small. In some cases no single company has enough vested interest in the technology to warrant marketing it in China, or there is no clear customer. In many of the industrial applications, however, U.S. companies would be competitive.

Solar

The only solar technology that is likely to be at all significant is photovoltaics. At least one U.S. company is discussing the possibility of setting up a manufacturing plant in China. Other solar technologies are either not competitive or are already being implemented in China (e.g., flat-plate collectors). The technology that has been developed in the United States over the past 10 to 15 years would probably be helpful, but it is not clear if it will be economical for industry to provide it to China. This may suggest a greater role for the Department of Energy. China is also exploring the possibility of tapping its geothermal resources. This could be a significant area in the future, since the United States has done considerable R&D as well as limited exploitation.

CHINA'S PROBLEMS WITH TECHNOLOGY TRANSFER

The discussion above indicates China's need for foreign energy technologies, and its intense drive to acquire technology. China's ability to choose technologies wisely, assimilate them, and diffuse them are also questions which have concerned students of technology transfer to China. These are germane questions in light of China's modern history—its quest for technology since the 19th century, its concerns about the corrupting influences of foreign material culture which accompanied that quest, massive technology imports from the Soviet Union which occurred in the 1950s, and the confused technology policies of the government in the post-Mao period.

Finance

In comparison to other developing countries which are recipients of transferred technology, China has both distinctive advantages and disadvantages in dealing with technology from the international economy. First, as noted elsewhere in this memorandum, China is in a relatively favorable position in terms of its foreign exchange holdings, and has in its energy resources for export a source of foreign exchange earnings (the latter accounts for 20 percent of China's foreign exchange earnings). But China's energy needs are so great that it is difficult to find the necessary financial resources. Foreign exchange reserves could be dissipated quickly with major purchases (e.g., nuclear powerplants), and the uncertainties of the export potential of the energy industry for the remainder of the century in the face of rising domestic demand induces caution in the use of foreign exchange.

China's energy sector remains severely undercapitalized in spite of the fact that it receives 45 percent of industrial investment. This affects China's ability to solve the technological needs of its energy sector through technology transfer. While the energy industry is a foreign exchange earner, reportedly only 10 percent of the foreign exchange it generates is reallocated to the energy sector for its foreign procurement uses. Thus, financing is an important constraint on energy development, but it is one with a differential impact. Chinese investment decisions favor foreign exchange earners, and exportable energy sources —oil and coal—also have attracted private funds from abroad. Financing is a greater constraint in the electric and hydropower areas, where the Chinese have sought and are receiving concessionary loans from abroad.

Manpower

A second constraint facing many developing countries is a shortage of technical manpower, and a lack of a scientific tradition. These problems affect a country's ability to absorb foreign technology. China does have something of a manpower problem, and it also has technology absorption problems in the energy sector. Yet in absolute terms, China has a large pool of scientists and engineers (over 2 million).[12] Even though the quality of training received by those in the pool varies a great deal, and the distribution of talent by region and economic sector is unbalanced, China does have a cadre of technical specialists to facilitate technology transfers.

China is also rapidly expanding the technical manpower ranks through its own new educational policies, and by taking full advantage of educational and training opportunities offered abroad by institutions of higher education, companies, and foreign governments. Thus, while manpower inadequacies do appear in the context of technology transfers, China is also preparing itself for assimilating technology and benefitting from learning curve effects.

In contrast to many developing countries, China has an established energy industry, and an extensive R&D network. Thus, in the energy area, all sectors have research, design, and educational institutes which typically have more than 25 years of experience. Many of these had experience with technology transfers from the Soviet Union in the 1950s, and all of them had experience with technological self-reliance since 1960. This R&D system was terribly disrupted during the Cultural Revolution, and its capabilities were reduced. But it is important to recall the evolution of this system since 1949, and the many achievements it has made. It is a significant resource which should aid China in assimilating foreign technology, and avoiding technological dependency. China's technology absorption problems, thus are likely to be short-term problems; its technical community is extant and must be brought up to world levels. It does not have to be created de novo.

Ironically, the existence of an established energy supply industry and R&D system at times works against technology transfer. The domestic industry has a vested interest in domestic supply, and thus China is faced with "make or buy" questions which would not trouble other developing countries. In addition, China's domestic industry has had trouble converting the results of its research into serially produced new products. Moreover, there has been a resistance to innovation on the part of Chinese managers. These problems, and the more general relative technological backwardness of the domestic industry, provide opportunities for the foreign suppliers of technology at the present time. It is likely, however, that effective international technology transfers will also stimulate the domestic industry to improve its capacity for indigenous innovation.

Internal Transfers

The question of how effectively foreign technology is diffused within China remains uncertain. Foreign firms have been concerned that technology licensed to one enterprise may illicitly be transferred to another, in the absence of effective patent protection. China's new patent law and other recent policies designed to encourage technology transfer, should help alleviate some of these concerns. A separate question, however, is the capability of the Chinese system for internal technological diffusion.

Chinese organizational life is excessively bureaucratic and compartmentalized. The Chinese themselves often lament what they refer to as "departmentalism." The result of these organizational characteristics is that there is often little effective horizontal, interorganizational communication. Instead, communications follow the strong vertical orientations according to which Chinese organizations were designed.

The Chinese have attempted to overcome these features by creating mechanisms for cross-cutting technological communications. The first of these are the professional societies organized around academic disciplines and industrial technologies. The professional societies, uniquely, draw individuals from different vertical systems (different ministries, academies, and universities) into a common forum. A second mechanism is a network of scientific and technical information services that have been established, the development of which has been aided since 1979 by cooperation with the U.S. National Technical Information Service. In addition to these two mechanisms, in recent years, a large number of technical consulting organizations have been formed, and other organizations, including production enterprises, universities, and research institutes, have been active in establishing consultancies as well. Recent policy has also sanctioned individual consulting.

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[12] See Leo A. Orleans, *The Training and Utilization of Scientific and Engineering Manpower in the People's Republic of China*, U.S. House of Representatives, Committee on Science and Technology, October 1983.

Thus, while the formal structure of the Chinese economic and research systems works to inhibit the diffusion of technology and ideas, the climate for the domestic supply of technical services and the diffusion of technology has improved markedly in recent years. Thus, the likelihood that China's investment in foreign technology will have more of a payoff—with advanced technology filtering out through the economy—is now greater than would have been the case in the immediate past.

Decisionmaking

Decisionmaking is another constraint on effective technology transfer experienced by developing countries, and China too has its share of decisionmaking problems. For instance, there has not always been good coordination among central ministries in the energy sector, and between decisionmakers in Beijing and those at the province level. Decisionmakers in Beijing making purchasing decisions about foreign technology have not always had a good understanding of the technical problems in the field. Perhaps most importantly, China's economic system has over the years structured incentives in such a way that decisionmakers are often risk averse. Individuals have been unwilling to make decisions without collective consensus. The resulting delays in decisions are costly to foreign companies who face high daily expenses to maintain representatives in China.

The current economic reforms promise some improvement in decisionmaking, however. In an effort to put China's energy industry on more of a business-like footing, management has in many cases been removed from government ministries and vested in new corporate entities, such as the China National Oil Development Corp., which in principle, are to run as profit-making organizations. Efforts are being made throughout the government and the economy to promote younger, more technically qualified and more entrepreneurial individuals into managerial positions. The mechanisms for horizontal technical communication, noted above, also serve to aid in Chinese decisionmaking. It seems to be the case now, although this was not true in the late 1970s, that decisionmaking about what types of technology to import is informed by some of the best technical judgments available in China. This is largely a result of the growth of consulting and advisory services.

This is not to say, however, that such decisionmaking is now problem free. The best technical judgments do not necessarily result in the most appropriate technology decisions, and it does seem to be the case that the full integration of technical, economic, and political criteria remains something of an ideal. China's increasing exposure to the international economy, and particularly to international organizations, has now sharpened the Chinese sense of the importance of project planning and analysis, and efforts have been made by both the Chinese themselves, and with the assistance of organizations like the World Bank, to strengthen central analytic capabilities, and capabilities for coordinated decisionmaking, on technology transfer decisions.

The current economic reforms should improve China's ability to absorb and diffuse technology in other ways as well. Technology as an economic concept has undergone a fundamental change in Chinese thinking. Whereas in the past it was regarded as a free public good, which in a socialist society is available to any and all, technology now is regarded as a commodity to be bought and sold through market transactions. The Chinese hope that this new conception of technology will provide better incentives for those who produce technology, and will make those who would procure and use it, more conscious of its economic value. More effective internal technology transfers, and sharper microeconomic decisionmaking are expected.

Conclusion

On balance, in spite of financial, manpower, and decisionmaking problems which limit its ability to procure and assimilate technology, China also has capacities which make these limitations less of a problem than they have been in other developing countries. These include an expanding pool of trained personnel, an established energy industry with an extensive R&D system, and new policies to encourage foreign investment and technology transfer, as well as those for economic, administrative, and educational reform, which seem appropriate for China's current needs. Whether these policies will succeed and whether the associated political and social costs can be managed are major uncertainties.

China's leaders, however, have incentives to maintain an environment favorable to technology transfer and absorption. China's rate of economic growth for the remainder of the century will be constrained by energy production, yet the ability to maintain political support for the policies of modernization and reform is to a large extent a function of economic performance. Improving performance through the use of foreign technology thus has great domestic political significance for China's current leaders.

Chapter 4

Nuclear Power and the Proposed Cooperation Agreement

Chapter 4

Nuclear Power and the Proposed Cooperation Agreement

China has a strong interest in developing nuclear power to supplement its coal and hydroelectric resources. The severe power shortages, described in the previous chapter, suggest that all major options for additional electrical generating capacity should be considered, and nuclear energy has several important advantages. Nuclear plants can be located anywhere in the country where suitable sites can be found. The major population centers are near the coast, far from the great hydroelectric sites and larger coal deposits. Both electricity and coal can be shipped long distances, but that would require large additional investments in transmission or transportation networks which may be inefficient, unreliable, and vulnerable in case of war. Nuclear plants can be located relatively close to the points of demand with few requirements for transportation or transmission.

In addition, China has severe problems with air and water pollution. Much of this pollution is due to coal mining and combustion. Nuclear power is almost completely free from such problems except for waste heat emissions which can be managed reasonably well. Accidental radioactive releases and waste disposal, problems which have been of concern to many in this country, appear to be seen in China as manageable, acceptable risks. Thus if nuclear plants replace old polluting coal plants or even substitute for new coal plants with less than the best available control technology, the environment should be improved. Compared to coal, hydropower seems to be relatively benign, but it too can cause environmental problems (health effects from schistosomiasis and malaria, loss of land, interruption of natural flow patterns, catastrophic flooding from dam breaks). Reservoirs are also subject to siltation, limiting their lifetimes, and large hydropower projects can cause major social dislocations. For instance, it is estimated that the Three Gorges project would involve the relocation of from 300,000 to 1 million people. Thus, while there are certain risks associated with nuclear power, China's nonnuclear power options also have substantial costs.

China already has a significant nuclear expertise because of its weapons, submarine propulsion, and research programs. The military nuclear program, like the defense sector generally, is under policy instructions to use its relatively abundant technical resources to serve the civilian economy. Should this expertise not be used in the civilian nuclear sector, it would have to be redirected to entirely different fields. In the Chinese system, massive shifts of personnel are difficult to accomplish. Therefore, these people are more likely to contribute to the growth of the Chinese economy if a civilian nuclear power industry is created than by leaving them in the military or trying to retrain them to ease the shortage of engineers elsewhere.

Overall, nuclear power is an energy option at least as reasonable for China as it is for many nations that already have reactors. However, some of the causes of the worldwide slowdown in the growth rate of nuclear power may affect China's plans. First, reactors are extremely capital-intensive. Even when economic analyses show the final power costs to be lower than coal plants because of the low fuel costs for nuclear plants, a large amount of capital must be supplied before there is any return on the investment. In particular for importing countries, considerable foreign exchange must be spent for the reactor and major components (the cost of the nuclear steam supply system is about 20 percent of the total plant cost), even if attractive financing terms are included. The operation of reactors in some developing countries has been a disappointment. Some have operated well, particularly if a high level of services from supplier countries has been included, but most countries (including the United States) have found reactors considerably more complex and demanding than expected. Concerns over costs and safety have led to opposition in some countries.

China's ability to operate civilian nuclear reactors safely and reliably is, of course, untested. While general industrial workplace safety practices often appear to the foreign observer as very lax, it is also true that with regard to nuclear technology, China is not a typical developing country. Its nuclear industry has more than 25 years of experience, and has operated with few reports of accidents,[1] although there has been some concern expressed about low-level radiation exposure at the workplace.[2] China shows signs of taking issues of reactor safety seriously. It established the National Nuclear Safety Administration in October 1984, it has enacted new legislation for nuclear safety, it has sought the assistance of foreign governments (including the United States, see below) for establishing a regulatory framework, and it has begun to train a national team of nuclear safety officers with the assistance of the International Atomic Energy Agency (IAEA).[3]

Plans have been announced to build a total of 10,000 megawatts (MW) of nuclear power in China by 2000, a goal that is ambitious but not impossible.[4] Currently, China has 81,000 MW of generation capacity from all sources. To meet expected demand, this capacity will have to increase to 250,000 MW by 2000.[5] The addition of 169,000 MW in 15 years, however, would be a substantial achievement. This tripling of supply would match expected economic growth. Since most developing countries have experienced electrical growth considerably higher than economic growth (as was the case in the United States prior to 1973), a considerable increase in the efficiency of use is implied in the projections.

The only firm commitments for nuclear plants at present are for a 300 MW plant under construction near Shanghai (the 728 project), and for an imported plant in Guangdong. The former, growing out of China's naval propulsion program and analyses of foreign units of similar size, will be produced largely indigenously. The first large plant is to be built at Daya Bay in Guangdong province near Hong Kong using two 900 to 1,000 MWe units. Most of the power would be sold to Hong Kong, and the plants would be financed largely by foreign investors. It was expected that the nuclear components for the plant would be supplied by France (with the generators coming from the United Kingdom). However, despite protracted negotiations and reported near agreement, no contract has been signed, and recently, China solicited competing bids from West Germany. It is not yet clear if this indicates a major problem with the French bid or is a tactic to wring more concessions. Sites have been chosen for two follow-on projects in Jiangsu and Liaoning provinces. Proposals for the former are being considered. Again, the French and the Germans are expected to be the main competitors. Japanese firms are also anxious to participate, and free to bid on projects since the two countries signed an agreement on nuclear cooperation in August 1985. U.S. companies cannot compete unless a nuclear cooperation agreement is in force.

China's dual approach of developing indigenous capabilities and importing foreign equipment and technology is intended to minimize the time needed to master nuclear power technology by incorporating the best available on the world market, while ensuring that the program does not get too dependent on foreign sources. China could develop reactor technology on its own if it had to, but that approach would take considerably longer and cost considerably more before reaching the present level of western nuclear technology.

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[1] For an exception, see Mark Baker, "Peking Admits Accident at Atomic City," *The Financial Times*, Dec. 9, 1983.

[2] Zhang Yongxiang, "Radiation Protection Assessment of the Past 20 Years of Operation of the First Heavy Water Reactor in China," *Fushe Fanghu (Radiation Protection)*, No. 5, September 1983, in Joint Publications Research Service JPRS-CST-84-016,6-20.

[3] *Xinhua*, May 18, 1985, in Foreign Broadcast Information Service, *China Report*, May 23, 1985, p. A2.

[4] Jiang Xinxiong, "China's Nuclear Industry in the Last 30 Years and Its Future," *Industrial Equipment & Materials*, vol. VI, No. 4, Hong Kong.

[5] *Dianli Jisha* #11, November 1983, JPRS-CEA-84-026.

PRESENT CAPABILITIES

China has a substantial nuclear industry which was created originally for military purposes. This industry developed nuclear weapons (both fission and fusion) in a remarkably short time (the first fission bomb was tested 4 years after the break with the Soviet Union, the first fusion bomb less than 3 years later). Since then, China has produced at least several hundred warheads. It has also built plutonium production reactors, enrichment plants, and various research facilities including other types of reactors. In addition, it developed, largely independently, the pressurized water technology (which the United States uses in its navy and commercial power industry), and has built at least four nuclear-powered submarines. These programs are discussed in more detail below. The important point to note here is that China is not at all a typical developing country in terms of nuclear technology. Total employment in the nuclear industry is estimated at 100,000 to 150,000 people.[6] The Chinese Nuclear Society has over 20,000 members, a rough indication of the number of scientists and engineers with nuclear skills. Figure 2 shows an organizational chart of the Chinese nuclear industry.

The 728 or Qinshan project has emerged from the military sector in an effort to convert this expertise to civilian use. According to one report, as many as 4,000 people were transferred from military work to the 728 project.[7] Recently, a spokesman for China's Atomic Energy Industrial Co. estimated that the nuclear industry is in the process of shifting from 80 percent military work to 80 percent civilian.[8] There are conflicting reports of the progress of the 728 project, but the officially announced goal for operation is 1989. Preliminary site work has been completed, major components have been ordered, and construction of the main buildings started. Most compounds will be made in China. However, the reactor pressure vessel has been ordered from Japan, and its delivery was given a one time special approval by the Japanese Government in the absence (at that time) of a nuclear cooperation agreement between Japan and China.[9]

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[6] Personal communication with the American Nuclear Society.

[7] Gerard Gourievidis, "Nuclear Power in China," *Revue Generale Nucleare*, July-August 1984, pp. 358-368, in Joint Publications Research Service JPRS-CST-85-005, pp. 103-124.

[8] *Zhongguo Xinwen She*, May 3, 1985, in Foreign Broadcast Information Service, *China Report*, May 7, 1985, p. K11.

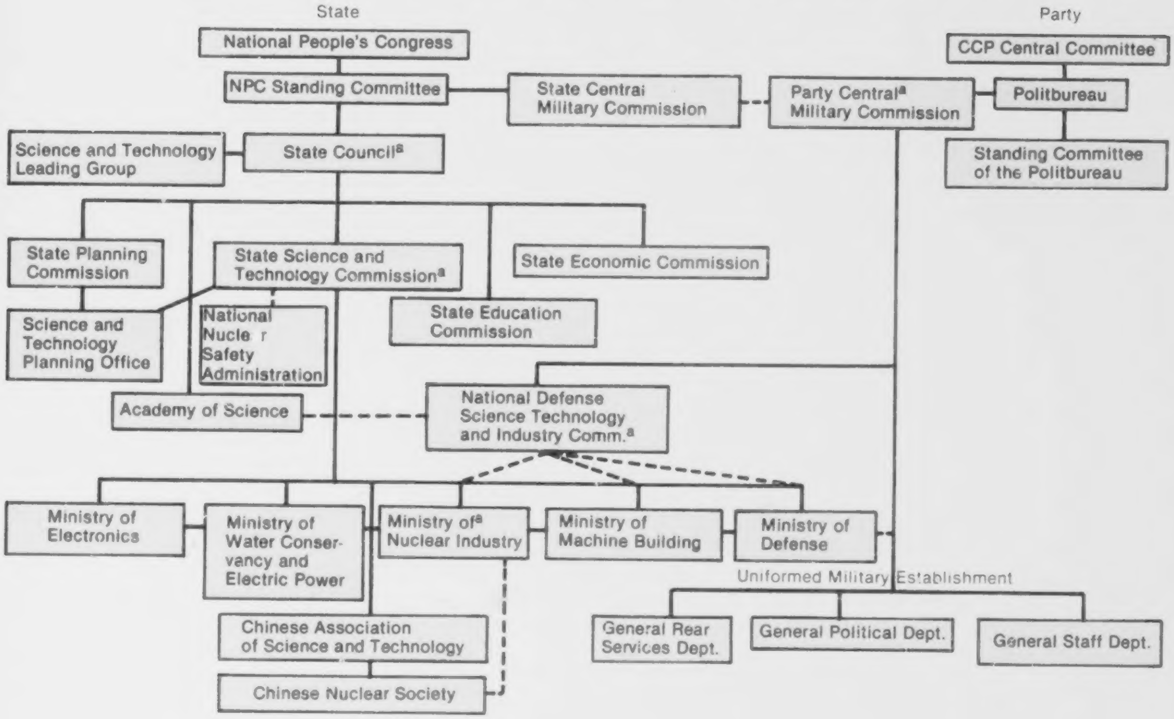
[9] China and Japan have now signed an agreement. (See *Chia Daily*, Aug. 1, 1985.)

THE ROLE OF IMPORTED TECHNOLOGY

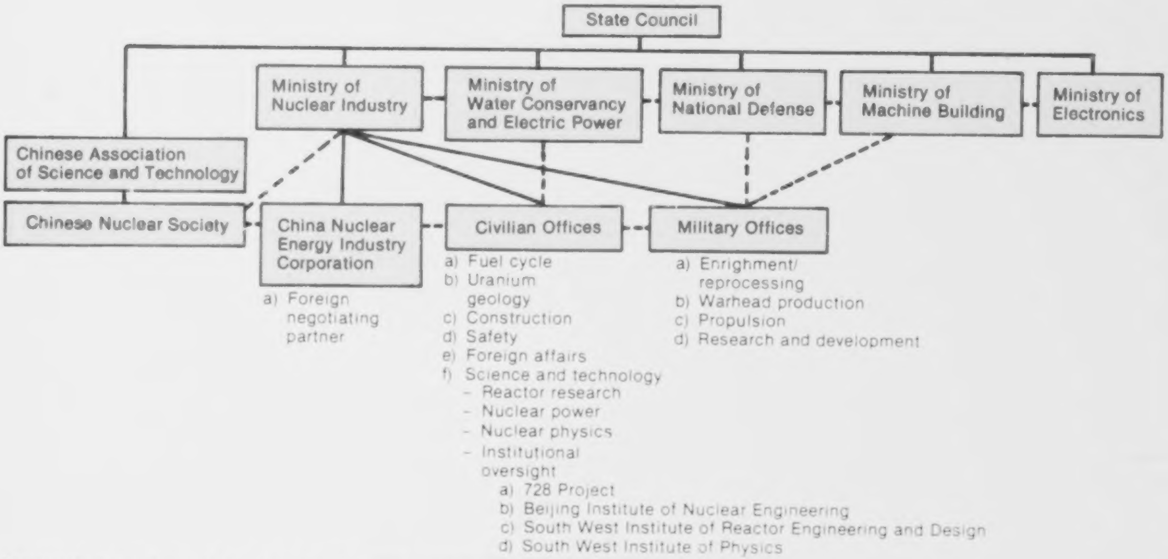
China has started work on scaling up the 300 MW design of the 728 project to 600 MW, but the domestic industry will not have the designs or the manufacturing capability to meet the 10,000 MW goal by 2000 without foreign technology. Several countries would like to sell complete reactor systems: the United States, France, West Germany, Japan, and the U.S.S.R. all could export the pressurized water reactors (PWRs) favored by China. Other types of reactors are heavy water (Canada), gas cooled (Great Britain, Germany, and the United States) and boiling water (United States and Sweden). The differences among the various PWRs are technologically important in detail, but not very significant from an economic, safety, or policy standpoint. The United States, however, is the only country that has actually transferred the complete technology, as distinct from selling the equipment. The French, German, and Japanese designs are derived from U.S. PWR technology, and royalties have been paid to American companies.

This record in technology transfer is one of the main reasons that China would still like to deal with American companies despite delays in the nuclear cooperation agreement. China has made it clear that it intends to absorb the technology and develop its own capability to manufacture large reactors. By the fourth project, the Chinese hope to be able to supply 80 percent of the parts themselves, although this may be an unrealisti-

Figure 2.—Nuclear Policy Decisionmaking Organization


State
Party
National People's Congress
NPC Standing Committee
State Central Military Commission
Party Central[a] Military Commission
CCP Central Committee
Politbureau
Standing Committee of the Politbureau
Science and Technology Leading Group
State Council[a]
State Planning Commission
State Science and Technology Commission[a]
State Economic Commission
Science and Technology Planning Office
National Nuclear Safety Administration
State Education Commission
Academy of Science
National Defense Science Technology and Industry Comm.[a]
Ministry of Electronics
Ministry of Water Conservancy and Electric Power
Ministry of[a] Nuclear Industry
Ministry of Machine Building
Ministry of Defense
Uniformed Military Establishment
Chinese Association of Science and Technology
Chinese Nuclear Society
General Rear Services Dept.
General Political Dept.
General Staff Dept.

Nuclear Policy Implementation


State Council
Ministry of Nuclear Industry
Ministry of Water Conservancy and Electric Power
Ministry of National Defense
Ministry of Machine Building
Ministry of Electronics
Chinese Association of Science and Technology
Chinese Nuclear Society
China Nuclear Energy Industry Corporation
a) Foreign negotiating partner
Civilian Offices
a) Fuel cycle
b) Uranium geology
c) Construction
d) Safety
e) Foreign affairs
f) Science and technology
- Reactor research
- Nuclear power
- Nuclear physics
- Institutional oversight
a) 728 Project
b) Beijing Institute of Nuclear Engineering
c) South West Institute of Reactor Engineering and Design
d) South West Institute of Physics
Military Offices
a) Enrighment/ reprocessing
b) Warhead production
c) Propulsion
d) Research and development

[a] Represents the most important nuclear affairs decisionmaking organizations.

SOURCE: Office of Technology Assessment.

cally high goal. Even Japan does not supply all components for its reactors. Considering their great need for new generating capacity, their limited foreign exchange (sizable relative to most developing countries, but small relative to their overall needs and the cost of a nuclear program) and their existing nuclear capability, eventual self-sufficiency is probably a realistic and necessary goal.

The first project, Guangdong, would involve the import of all important components. As noted above, the nuclear island (reactor, primary pumps, and steam generators) was expected to come from France, and the generating components from Great Britain. The recent German bid received from Kraftwerk Union, however, has reportedly led the Chinese to rethink their decision. The German bid is for four 1,000 MWe units—two for Guangdong, and two for the follow-on project ("Sunan") in Jiangsu—and provides for the Chinese to supply 20 percent of the components for the first project and 80 percent for the fourth. China would have to pay a surcharge for the technology if the fourth plant is not ordered within 6 years after the order for the first.[10]

There is far more to a nuclear plant than equipment, however. Even if there is no attempt to transfer the technology to design and manufacture nuclear plants, a considerable amount of expertise must accompany the sale of equipment. For instance, quality control is a crucial concept: much of the plant will be built domestically, so it is necessary to understand plant safety and economic requirements and how to determine the specifications for various components and materials to meet these requirements. Operator training must be extensive to ensure that the plant will operate smoothly and that accident sequences can be terminated. Workers must be taught how to refuel and perform other kinds of maintenance. Health physicists must know how to determine exposures and how to minimize them. Computer programs must be supplied to determine fuel management programs, while chemists and metallurgists must understand the effects of radiation on materials.

If a manufacturing capability is included in the transfer, much more information must be made available. Even if a complete design is to be duplicated, each reactor will be a little different depending on site-specific characteristics and customer needs. Designers must know how these differences will interact with the full system. They also must know the manufacturing capabilities available, and possibly modify the foreign designs for components accordingly. Therefore they must know why components are designed the way they are and how they are expected to be manufactured. China has reverse engineered some technologies (duplicated them without access to manufacturing information), but the process is very difficult and uncertain of success, even for technologies much simpler than nuclear reactors. Designing and manufacturing reactors also requires scientists and engineers with a solid grasp of core physics, metallurgy, safety analysis, and all the other disciplines that go into designing a reactor. Even if the receiving country intends to manufacture only the fuel, a considerable amount of nuclear and metallurgical expertise must be transferred.

Specific areas where the Chinese feel foreign technology could improve their own capabilities significantly include advanced fuel fabrication, instrumentation, and construction management. Foreign participation in the 728 project includes in-core monitoring equipment from France and coolant pumps from Germany in addition to the pressure vessel from Japan.

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[10] *Nuclear Engineering International*, June 1985, p. 3.

PROLIFERATION CONCERNS

Preventing the spread of nuclear weapons has been a major objective of this country's foreign policy for many years. We have shown that we are prepared to forego attractive commercial opportunities and expend diplomatic capital as part of this commitment. It is a basic tenet of U.S. policy that American technology not be used by any other country to produce nuclear weapons, although the policy has not always been applied consistently.

One proliferation concern is that some spent fuel from commercial power reactors could be reprocessed to separate the plutonium, which is the key material in nuclear explosives. Studies of proliferation, including OTA's,[11] have concluded that this is a possible, though relatively unlikely route to nuclear weapons under most conditions. The plutonium generated under normal PWR operation is far from ideal to work with, and as long as safeguards are applied, a country runs a considerable risk of being detected if it diverts spent fuel, thereby opening itself to sanctions or even hostile action. A circumstance that could lead to diversion (as opposed to building facilities such as a small reactor and reprocessing plant dedicated to producing plutonium, possibly clandestinely) might be a desperate military situation which required a very rapid introduction of nuclear weapons.

Since the technology could be used in a weapons program, importing countries must agree to certain terms in order to obtain U.S. equipment and other forms of assistance. Typical terms are signing the Non-Proliferation Treaty or accepting equivalent safeguards, and agreeing not to retransfer the technology to other countries or reprocess fuel supplied by the United States or irradiated in U.S.-supplied reactors without prior U.S. permission.

China, however, is a special case. One argument against the likelihood of the diversion route is that the plutonium contained in spent fuel, reactor grade plutonium, would result in low yield, unreliable weapons unless the bomb designers were very good. China obviously has very good bomb designers; therefore, unlike practically every other developing country, it could make reliable, high yield weapons (at least in the kiloton equivalent range) from reactor grade plutonium. Furthermore, with a substantial nuclear power program, it could easily produce some fuel which had only a short exposure in a reactor, resulting in weapons grade plutonium. Not only can much higher yields from smaller weapons be obtained with weapons grade plutonium, but the material is easier to handle, and it generates much less internal heat, thereby increasing the shelf-life of the weapon, and making maintenance of the weapon easier.

Diversion of weapons grade plutonium would be easier if China builds liquid metal fast breeder reactors. The Chinese are not known at this time to have any specific plans to build breeder reactors, but they do have an interest in the technology, and have a research program which could enable them to start building in the next century. Considering their relatively small proven reserves of uranium, enough after military uses to fuel 15,000 MW for a normal plant lifetime,[12] this interest is consistent with their projections for the growth of light water reactors. Uranium prospecting continues (with foreign participation), and it appears likely that considerably more uranium will be discovered. China thus may find breeders uneconomic for many more years.

Despite the relative ease with which China could use commercial nuclear power technology to facilitate the acquisition of fissionable materials for weapons purposes, it is unlikely that China's interest in nuclear technology transfer is based on a desire to do so. It already has several hundred nuclear weapons and all the dedicated facilities it needs: over a dozen reactors for research and plutonium production, and reprocessing plants and enrichment plants that can produce high enriched uranium for weapons. Fissile material does not seem to be a constraint on their weapons production: if anything they have excess capacity. Effective delivery systems are a more likely constraint. China has already tested at least 26 fission and thermonuclear warheads (see table 7). Presumably, this is only a small fraction of the number it has stockpiled. Therefore, China already has a significant arsenal and the ability to produce as many more as it is likely to be able to use. What China does not have is civilian nuclear power technology.

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[11] U.S. Congress, Office of Technology Assessment, *Nuclear Proliferation and Safeguards* (New York: Praeger Publishing Co., June 1977).

[12] W.P. Geddes, "The Uranium and Nuclear Industries in China," *Resources Policy*, vol. 9, No. 4, December 1983, p. 243.

Table 7.—Nuclear Test Chronology, October 1964 to January 1981

Test	Date	Yield	Location	Delivery system	Remarks
1	16 Oct 64	20kt	Lop Nor	70 meter tower	U-235 produced yield
2	14 May 65	20-40kt	Lop Nor	TU-4 type A/C	U-235 produced yield
3	9 May 66	200+kt	Lop Nor	Hong 6 Bomber[a]	U-235+Li-6 produced yield
4	27 Oct 66	20kt	Lop Nor	CSS-1 MRBM	U-235 produced yield
5	26 Dec 66	300-500kt	Lop Nor	Tower	U-235+Li-6 produced yield
6	17 June 67	3mt	Lop Nor	Hong 6 Bomber	U-235, U-238, heavy hydrogen+Li-6 for yield
7	24 Dec 67	15-25kt	Lop Nor	Hong 6 Bomber	U-235, U-238+Li-6[b] produced yield
8	27 Dec 68	3mt	Lop Nor	Hong 6 Bomber	U-235 fuse; Li nucleus; U-238 crust; traces of plutonium in fallout
9	22 Sep 69	25kt	Lop Nor	Underground	
10	29 Sep 69	3mt	Lop Nor	Hong 6 Bomber	Fusion device
11	14 Oct 70	3+mt	Lop Nor	Hong 6 Bomber	Fusion device
12	18 Nov 71	29kt	Lop Nor	High tower	Nuclear device
13	7 Jan 72	20kt	Lop Nor	CSS-2 IRBM	
14	18 Mar 72	100-200kt	Lop Nor	CSS-3 ICBM	Limited range
15	27 Jun 73	2-3mt	Lop Nor	Hong 6 Bomber	
16	17 Jun 74	200kt-1mt	Lop Nor	Unreported	"not good"[c]
17	28 Oct 75	2-5kt	Lop Nor	Underground	
18	23 Jan 76	2kt	Lop Nor	Atmospheric	
19	26 Sep 76	10kt	Lop Nor	Atmospheric	Special weapon
20	17 Oct 76	20kt	Lop Nor	Underground	
21	17 Nov 76	4+mt	Lop Nor	CSS-4 ICBM	Full range[d]
22	17 Sep 77	20kt	Lop Nor	Atmosphere	
23	15 Mar 78	6kt	Lop Nor	Atmosphere	
24	14 Oct 78	20kt	Lop Nor	Underground	centered 44.5 N, 88.6 E
25	14 Dec 78	20kt	Lop Nor	Atmospheric	Nuclear bomb
26	16 Oct 80	200kt-1mt	Lop Nor	Atmospheric	

[a] PRC production model of the Soviet TU-16/Badger medium range for bomber

[b] Unsuccessful—only the fission stage completed

[c] Unsuccessful—PRC and France had detonations the same date

[d] Hydrogen warhead for a long ange ICMB

SOURCE: Strategic Digest, June 1983

While it seems reasonable to dismiss concerns that the Chinese would misuse American technology to make nuclear explosives, U.S. policymakers are rightly concerned about the proliferation implications of possible future Chinese nuclear exports, particularly the reexport of technology of U.S. origin without rigorous safeguards. This reexport issue has been of particular concern to some because of reports of past Chinese exports of enriched uranium and heavy water, without requiring safeguards, to countries which have not signed the Nuclear Non-Proliferation Treaty. Although the United States has a special responsibility for guarding against unsafeguarded reexports of U.S.-supplied technology, it should be noted that the question of China's exports pertains to China's own technology and to technology supplied by other countries, as well as to that supplied by the United States. In addition, the technologies of greatest concern from a proliferation perspective are enrichment and reprocessing plants. China is already proficient in these technologies, which presumably would not be transferred from the United States in any case.

The concern over reexport, therefore, is less over the technology itself than over the political damage to the entire nonproliferation norm should the terms of U.S.-China cooperation be lax on this point. U.S. interests would be served not only by having strong protections in the agreement against the reexport, without rigorous safeguards, of technology of U.S. origin, but also by China's moving toward a nuclear export policy which is in line with that of other suppliers. It is not clear whether China is moving towards such a position, but proponents of the nuclear accord believe both that it is, and that the existence of such an agreement will aid in bringing China more closely in line with U.S. nonproliferation interests. This belief is reflected in the ACDA Nuclear Proliferation Assessment Statement (p. I-4) submitted to Congress along with the recently signed U.S.-China nuclear agreement. (A copy of the agreement, and the supporting documentation, is included in the appendix.) Critics believe that the evidence supporting this view is too limited to justify the risk of an agreement without strict protections. This issue and other implications of a nuclear agreement are discussed further below.

OTHER MILITARY CONCERNS

PWR technology was developed for the U.S. submarine program. It was seen later that this technology could also be used for commercial powerplants. Reactors much larger than those in submarines but conceptually quite similar now produce most of the nuclear power around the world. Since powerplants were derived from propulsion units, it has been suggested that the process could be reversed: a nation with power reactors could use the technology in hand to design and construct a naval reactor.

China already has at least four nuclear submarines. There are two types: attack submarines (SSN), the first of which was launched in 1972, and missile submarines (SSBN), first launched in 1981.[13] The latter is capable of carrying about 16 missiles, but is still in the testing stage. China tested its underwater launched ballistic missile for the first time in 1982 from a nonnuclear submarine. This missile was reported to have a range of about 2,000 miles. The next generation missile could have a range of about 4,000 miles.

These submarines are not now a major element in China's strategic strike capability, although they could be in the mid to late 1990s. Even without leaving the Chinese coastal regions, they can strike almost all of the Pacific coast of the Soviet Union. The advanced missiles could strike Moscow. As of now, the Chinese seem to have no intention of sending submarines on distant operational patrols. Considerably more support services would be required to go even as far as the Indian Ocean. That means that they are not taking advantage of the extended range of nuclear reactors. The additional cost of the nuclear power presumably was justified by their ability to stay submerged for long periods to avoid detection. Developing a fleet of nuclear submarines would be a necessary step if China intends to become a world power.

As discussed above, China seems to be following the U.S. example of developing power reactors from the naval technology, but there is some reason to believe that having access to the latest power technology could help them improve their submarines. It has been reported that their submarines are relatively noisy, making them easy to detect.[14] They do not venture far from ports, possibly because of concerns over reliability and guidance system adequacy. U.S. submarines have improved dramatically over the past 30 years in speed, range, reliability, and quietness. While the development programs in this country for naval and power reactors have been quite separate, some of the technological improvements would have been common to both, such as quality assurance, materials, and analytical techniques.

No one has yet suggested to OTA a specific improvement that would derive directly from modern power reactor technology and make a substantial difference in the performance of Chinese submarines, but there is a general feeling among engineers that this access would be useful. Reactor cores could be made more powerful and efficient if designers could use the latest information and computer codes; components, such as control rods and pumps, could be made more reliable, quieter (though the U.S. Trident submarine has a natural circulation reactor, eliminating the need for the large and noisy primary coolant pump), and less subject to corrosion; systems analysis can improve integration of the entire design; quality control would improve, thus increasing reliability. Many of China's best performing factories have been stimulated by exposure to Western practices. Nuclear power should be no different even though power reactors and naval reactors are quite different in size, power density, mission requirements and economic criteria.

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[13] David G. Muller, Jr., "China's SSBN in Perspective," *Naval Institute Proceedings: Professional Notes*, March 1983, p. 126.

[14] Defense Intelligence Agency, *Handbook of the Chinese People's Liberation Army*, November 1984, p. 57.

It must also be noted, however, that it makes little difference whose PWR technology is transferred. There is significantly less difference among PWRs from the United States, France, Germany, or even the U.S.S.R. than between any of these and a naval reactor. Thus if the Chinese buy any modern PWRs, they will have essentially the same expertise that they would have had from the United States. The only significant difference, as discussed above, is that the United States has unique experience in transferring the technology to manufacture nuclear reactors and assisting another country to develop a nuclear industry. Other countries now stand ready to try, and will if the price is right, but China probably would prefer to rely on the United States.

Furthermore, in so far as the valuable commodity to be transferred is exposure to modern nuclear industrial practices, it makes little difference which type of reactor is transferred. Thus boiling water reactors or even gas reactors, which would not themselves be used in nuclear powered ships, would provide some of the same advantages to the Chinese in improving their submarine PWRs.

NUCLEAR COOPERATION AGREEMENT

The U.S. and Chinese governments have cooperated on an agency-to-agency basis in the field of nuclear *safety* since the signing of a protocol to that effect in October 1981. Under the protocol, the Nuclear Regulatory Commission has transferred to China a basic set of NRC safety documents, including regulatory rules, safety guides, technical reports, and safety assessment computer codes.

A government-to-government nuclear cooperation agreement, which among other things would permit the U.S. nuclear industry to participate in China's nuclear development program, was initialed during President Reagan's visit to China in April 1984. It was signed in Washington on July 23, 1985, and forwarded to Congress with supporting documentation on July 24. The text of the agreement and the supporting documentation is appended to this technical memorandum. Included in a separate volume is a discussion of the issues raised following the initialling of the agreement (Background Paper 2). Congressional policy considerations are also discussed in chapter 5 below. In addition, the Issue Brief from the Congressional Research Service, "Nuclear Energy: Consideration of the Proposed Agreement for U.S. Nuclear Cooperation with China" by Warren H. Donnelly is included in the background papers because of its thorough treatment of the issues and the congressional role in the agreement.

This section reviews some of the issues raised in the debate prior to the signing of the agreement, and discusses how cooperation, or its rejection, might affect international proliferation control and relations between the two countries.

As discussed above, China is unlikely to divert nuclear material produced from U.S.-supplied technology, but there are several other aspects to the proliferation issue. The first is based on concerns over China's past nuclear export behavior. It has been widely reported that China has aided a Pakistani effort to design and construct a centrifuge enrichment plant (and perhaps, nuclear weapons), but OTA has not obtained classified information to verify this charge. Such actions would indicate a serious disregard for the goal of stopping the spread of nuclear weapons. Even the less serious allegations of unsafeguarded shipments of enriched uranium and heavy water to Argentina and perhaps South Africa would still be major breaches of the international nonproliferation regime, although these alleged actions may be more indicative of past Chinese insensitivity to proliferation problems than a conscious disregard for nonproliferation objectives.

China's nonproliferation policy appears to be getting closer to that of the United States and other suppliers. China joined the IAEA in January 1984, and there have been no reports of contracts for unsafeguarded exports since then. China's leaders have pledged to require safeguards on all future exports and to refrain from assisting any other country to proliferate. If one believes that the allegations of previous assistance to potential proliferators are true, but no longer reflect the position of the Chinese leaders, then one might be willing to dismiss them in thinking of future relations. In the 14 months between the initialling of the agreement and its signing, the executive branch has attempted to ascertain the details of China's nuclear export policies and behavior, and has concluded that China's current export policy is consistent with U.S. nonproliferation objectives. (See, ACDA Assessment Statement, attached.) Nevertheless, some observers have held that since the alleged exports were so recent and so inimical to U.S. interests, and since they may in fact be continuing even now, a heavy burden should lie on China to show that it is complying and will continue to comply with nonproliferation norms before the United States extends any nuclear cooperation. Since conclusive evidence on past and present behavior, if it exists, has not been made available, OTA is unable to determine which view is best supported by the facts.

In the period since the initialling of the agreement, and in light of the fact that China has not signed the Non-Proliferation Treaty, there has been considerable discussion about the nature of China's nonproliferation pledges. The concern has been that China's pledges have only been verbal. Some analysts have felt that a pledge is uncertain unless it is put in writing with explicitly agreed upon wording. They point out that written assurances can be made with more explicit detail; spoken words can always be reinterpreted or disavowed later. Other analysts, however, believe that a verbal pledge has as great a force if made in the appropriate diplomatic context.

Premier Zhao Ziyang has stated publicly that China does not favor proliferation and will not help other nations. One such occasion was a toast at a state banquet, another was before the Second Session of the Sixth National People's Congress, which approved of Zhao's statement. Vice Premier Li Peng has been more explicit in elaborating on Zhao's statement in an interview with the press in January 1985. In light of the role and powers of the National People's Congress (which is a forum for announcing and ratifying policy, but which does not have the power to constrain the Communist Party leadership), and the fact that the Chinese press is a vehicle for advancing state policy, there is little reason to doubt that China meant to go on record with the nonproliferation statements of Zhao and Li. This, however, does not alleviate the concerns of those who wish to see pledges in writing, preferably committing China to adhere to the terms of the Non-Proliferation Treaty.

For historical reasons, the Chinese are extremely sensitive about infringements on their national sovereignty. However, since the Chinese also have been relatively isolated from the international community until recently, they have not been parties to the various international regimes, including the nonproliferation regime, established since the end of World War II. These regimes, in effect, proscribe national sovereign rights to achieve multilateral collective benefits, and the Chinese are only slowly coming to accept this principle. In light of this, the provisions for safeguards and reprocessing, as lenient as they may appear to be relative to other cooperation agreements, represent a significant concession by China.

With China's entry into the IAEA, and with the signing of an agreement with the United States (as well as with other countries earlier), China is now much more committed, in writing, to nonproliferation norms than was the case as recently as 2 years ago. Assessing the value of these written commitments for the furthering of nonproliferation objectives awaits detailed analysis of the language of the agreements.

The second major issue is over the safeguards to be applied directly on U.S. exports to China, which if the agreement were put in force, would be the first nuclear weapons state with whom the United States had a bilateral agreement. Such safeguards are required in all our other nuclear agreements, and are normally applied by the IAEA. Functionally, such safeguards are somewhat irrelevant in the case of weapons states such as China, and IAEA safeguards are not required by U.S. law. Symbolically, however, they have importance. The United States and Great Britain have accepted safeguards on all civilian facilities (although they are in effect applied to only a few) in order to subject themselves to the same burden as nonweapons states, and recently the U.S.S.R. has entered into an agreement with the IAEA for safeguards on certain civilian facilities selected by the Soviets. There is already a considerable feeling of discrimination on the part of some nonweapons states, especially among the developing countries, over their treatment by the supplier states. Granting lenient terms to China, itself a developing country, could lead to demands by these nations that they be accorded equal treatment. This point is disputed by some who find that developing countries do not regard safeguards in weapons countries (including China) as meaningful in any case.

Other supplier countries might also seek to take advantage of lenient terms in a U.S.-China nuclear agreement. The United States has a record of insisting on strong safeguards and has had some success in getting other suppliers to go along. If the U.S.-China agreement is seen as inconsistent with this position, it could be more difficult in the future to bring pressure on other suppliers.

The safeguards provisions of the U.S.-China nuclear accord reflect the fact that the agreement is between nuclear weapons states. The language is quite different from other recent agreements, and no provision is made for IAEA inspections. IAEA inspectors check operating records and the spent fuel, and keep records to ensure that the fuel has not been removed from authorized locations. Spent fuel is rather easy to safeguard in this manner, but it does call for diligence and continuity. Visits without careful materials accountancy would have little credibility from a safeguards perspective. The agreement does provide for negotiations through diplomatic channels to establish visits by U.S. personnel to Chinese facilities employing U.S. technology and/or possessing U.S.-supplied materials. The ACDA Assessment Statement reflects a U.S. understanding that the terms of the visits will be linked to the approval of export licenses (p. II-4). The language of the agreement itself is less clear on this point. The agreement also calls for the exchange of information on materials accountancy, but it is not clear how detailed this information would be. This lack of specificity may lead to misunderstandings or problems from differences of opinion.

The safeguards issue became politically more complicated after the agreement was initialed: China signed nuclear agreements with Brazil and Argentina that call for the reciprocal application of IAEA safeguards on nuclear materials and technology (reportedly, with specific reference to "moderator materials" in the agreement with Argentina), and agreement has been reached with Japan for IAEA safeguards as well. Such provisions may reflect the growing realization of the importance of nonproliferation. The recently signed agreement with the United Kingdom, however, does not require IAEA safeguards (on nonsensitive nuclear technology), nor do the earlier agreements with Belgium and Germany. However, in light of the precedent set in the agreements with Brazil and Argentina, some Members of Congress have expressed the belief that as part of a continuing effort to strengthen the nonproliferation regime, the U.S. agreement should provide for nothing less.

In a closely related issue, U.S. nuclear agreements with other countries also contain "consent rights" provisions, according to which fuel supplied by the United States or irradiated in U.S.-supplied reactors cannot be reprocessed without our permission. Reprocessing plants are far harder to safeguard than spent fuel pools, and if separated plutonium is available, there would be many more opportunities for diversion or theft by terrorist groups. It has been U.S. policy to discourage reprocessing, particularly in developing countries, for these reasons.

The consent rights provisions of the agreement may be the most controversial section of the accord. The agreement does not state explicitly that U.S. permission is required. Instead, it states that neither party has any plans to reprocess fuel supplied under the terms of the agreement and makes provision for a two-stage consultation process should the plans of the parties change. The two parties agree to enter into a 6-month period of negotiations to reach a long-term agreement for reprocessing. If, at the end of the 6-month period, no long-term agreement has been reached, the two parties agree to consult on measures that would allow reprocessing on an interim basis. During these consultation phases, the parties pledge not to take any action that would prejudge the long-term agreement or adversely affect cooperation under the nuclear agreement. The agreement is vague, however, as to what would happen in the event that consultations do not produce mutual agreement. Implied, is a right for either party to cease cooperation if an agreement is not reached. As with the provision on safeguards, ambiguity in the agreement may create problems of interpretation later.

As noted in the discussion of proliferation concerns above, it is unlikely that China would wish to divert spent fuel from civilian power reactors to its weapons program. Nevertheless, the consent rights provision is unorthodox, and is likely to spur debate on two issues. The first is whether U.S. consent rights are upheld to the extent required by Section 123 of the Atomic Energy Act as amended. The second is whether the language of the agreement with China will compromise U.S. efforts to strengthen consent rights provisions in agreements with other countries. Further complications are the facts that China already has reprocessing experience (although not with spent fuel from commercial power reactors) and that it has expressed an interest in reprocessing eventually, including possibly spent fuel it accepts for disposal from other countries. Thus, reprocessing need not involve fuel of U.S. origin, or fuel irradiated in U.S. reactors, but if the commercial promise of the agreement is realized, China would have a significant supply of fuel subject to U.S. consent rights.

Nuclear cooperation with China could result in a significant amount of business, perhaps several billion dollars over the next few years, for an industry that has little prospect for U.S. orders. If carried out unskillfully, it could make our nonproliferation efforts with other countries more difficult. The nonproliferation regime might be undercut directly if China does not honor its pledge to require safeguards on exports, and its naval reactor program could get an unintended assist, but these problems could occur with technology from other suppliers as well. On the plus side, cooperation can also help draw China into the nonproliferation regime, and could help build ties between the two countries.

These are risks and benefits that cannot be well quantified, but are nonetheless real. Rejecting the agreement would have implications that are even harder to define. Obviously U.S. firms, who have already lost commercial opportunities, would continue to lose the economic benefits of large-scale nuclear trade with China. A rejected agreement would be a major irritant to U.S.-China relations, but analysts disagree over whether rejecting the agreement, in itself, would cause lasting damage to bilateral relations. We would, however, lose most or all of our influence on China's nonproliferation policy and nuclear development program, including areas such as international spent fuel storage where we may wish at some later date to have maximal influence. We might also create dissension in the IAEA. We would further distance ourselves from our allies who believe that the risks of nuclear cooperation with China can be managed. Refusal to cooperate might even make nuclear cooperation with the Soviet Union more attractive to China. Thus, there are risks in not cooperating with China. Whether a stronger agreement could be negotiated, if it became certain that this one would not be accepted by Congress, is not clear.

Having an agreement in force also has risks. Should relations between the two countries sour, transferring nuclear technology might be regarded in the future as a serious mistake (although the threats to U.S. interests are only likely to be felt over the longer term—sometime after the year 2000). There are several potential risks that should be considered under such a scenario. If Chinese nuclear-powered submarines and eventual surface ships become good enough, they could venture as close to our shores as Russian ones do; U.S. defense expenditures might have to rise more than the value of the postulated sales in order to counter this additional threat. Even if China remains a regional power, adding to its strength may threaten U.S. allies such as South Korea. Improved nuclear technology could also enhance their capacity for destabilizing behavior elsewhere in the world, for instance by selling nuclear submarines to Brazil or Argentina.

People holding this perspective note that China is still a nondemocratic, one party state with a history of political instability, whose interests are not identical to ours, even strategically vis a vis the Soviet Union. Nuclear cooperation now would be seen as a significant vote of confidence in a political relationship which has not been proven, and could create a "carte blanche" atmosphere for export controls generally.

It should be noted, however, that other technologies being considered for transfer to China carry national security risks as well. Judgments as to the severity of the risks of nuclear, and other high-technology transfers are contingent in part on assessments of the nature of the political relations between the two countries (a subject not treated in great detail in this technical memorandum, but one to be taken up in greater depth in the full assessment). If political relations are regarded as good, and susceptible to improvement, then the risks of nuclear cooperation, and other technology transfers, can be seen as manageable in a process of building enhanced political understandings and commercial ties. If the relationship is seen as fragile, and inherently limited, then the risks are less tolerable.

While there has been widespread support (although by no means unanimity) for improved relations with China if they are based on a congruence of interest and a compatibility of thinking, opinion on nuclear cooperation is more complex. At least four general perspectives can be identified.

The first sees the development of U.S.-China relations since 1978 as a major achievement in overcoming nearly 30 years of hostility. Not only has hostility been overcome, but mutual interests have been identified, and friendship has developed. The possibility for building on those mutual interests is good and nuclear cooperation is part of that process. U.S. access and influence will help China towards a fuller understanding of and commitment to the international nonproliferation regime, and both economies will benefit.

The second view, though not necessarily unfriendly to China, places highest priority on nonproliferation. In this view, China's past behavior has been unacceptable, and its current stance, adopted only recently, is highly suspect. Therefore, approving any agreement without the strongest provisions on safeguards and assurances would be a blow to nonproliferation control. China should be called on to demonstrate its compliance before it is granted cooperation, and any significant doubt should be grounds for rejection.

The third perspective sees little use for nuclear power anywhere, especially in a developing country. China should be encouraged not to waste its limited money on highly expensive and risky reactors when other energy sources could fill the need at less cost. Thus nuclear cooperation would be a digression at best and possibly much worse.

Finally, there is the perspective which is very suspicious of China but not necessarily of nuclear power. China is likely to misuse our technology to our eventual dismay. As in the nonproliferation perspective, the burden of proof should be on China before it is aided, but the nature of the proof here would involve a broader set of issues, such as a closer adherence to U.S. diplomatic positions generally.

These perspectives are based on differing assessment of the risks and opportunities involved with trade with China as discussed above, as well as specific views on nuclear power. Definitive support or rebuttal is not possible at this time. Questions that Congress could ask include:

1. How well does the agreement comply with U.S. statutory requirements, particularly with regard to safeguards and reprocessing consent rights?
2. What is the evidence that China has helped Pakistan and other countries in ways we would find unacceptable? What is the evidence that this behavior is not now taking place?
3. How soon, and in what ways could the U.S. nuclear assistance effect China's industrial base as it pertains to the ability to produce improved nuclear weapons and warships? Would assistance from other major nuclear suppliers be any different?
4. What access does China now have to our national laboratories, companies involved in military work, and production facilities, and how would that change if we approve the nuclear cooperation agreement?

5. What financial assistance, if any, should the U.S. Government supply through the Export-Import Bank for the sale of nuclear reactors to China?
6. What will be the specific procedures for safeguards? What safeguarding arrangements do other major nuclear exporting countries have with China? Why has China not volunteered to submit its civilian facilities to IAEA inspections?
7. How do other Asian countries feel about improving China's nuclear capabilities?
8. How would other developing countries view U.S. nuclear assistance and financial aid to China when the United States may not provide either to some nonnuclear weapons states?
9. How does the fact that China now has nuclear cooperation agreements with all the major western suppliers (France, Germany, Britain, Japan), and with lesser suppliers (Brazil, Argentina, Belgium) affect the calculation of the costs and benefits of a U.S.-China agreement?

Chapter 5

U.S. Policy: Tools for Controlling and Promoting Energy Technology Transfers

Chapter 5

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The U.S. Government has available both controls and promotional programs that can be used to affect the scope and nature of energy technology transfers to China, within the overall context of U.S. foreign policy.

Export controls have historically been by far the more extensively used of these two avenues. For 20 years all U.S. exports to China were embargoed. It was not until the early 1970s when U.S.-China relations began to thaw that U.S. nonstrategic exports similar to those allowed for the Soviet Union were permitted. During the past 3 years, U.S. restrictions on exports to China have been significantly loosened in light of a dramatic shift toward encouraging Chinese economic modernization and U.S. trade. But controls remain central to U.S. policies affecting technology transfer to China.

The U.S. approach to policies governing technology transfer contrasts with those of other countries supplying technology to China such as Japan and some West European nations, not only in the more extensive use of controls but also because the United States has no aid program for China and does not use extensive official financing to promote energy-related development projects there. Science and technology exchanges are the major way the U.S. Government helps to develop China's science and technology infrastructure needed to absorb foreign technologies and innovate domestically. Many of these exchanges, however, contribute only rather indirectly to commercial technology transfers in energy fields.

U.S.-China relations have bloomed since the normalization of relations in 1979. Both the United States and China see technology transfer, particularly in energy, as a key area of cooperation. But despite the great expectations, doubts remain about U.S. willingness to transfer the most advanced and sensitive technologies, particularly those with military as well as civilian applications. This has caused some to question whether the U.S. commitment to export liberalization is really genuine, while others fear that the United States may be moving too quickly to export dual-use technologies without developing a comprehensive strategy.

In the sections that follow, disputes surrounding U.S. policies (both controls and promotional programs) that affect energy technology transfers to China are discussed and possible improvements outlined. The analysis indicates that the rationale for controls on militarily sensitive technologies remains valid, but problems in U.S. and Cocom export administration have created a climate of uncertainty. Additional steps could be taken to improve these systems, better focusing efforts on restricting flows of militarily sensitive exports. Most of the energy technologies that China wants, however, are not sensitive dual-use technologies. The U.S. Government could play a more active role in promoting these kinds of energy technology transfers.

Many of the improvements in policy that could be considered are not easily susceptible to congressional action. Indeed, some of the long-term policy issues raised below cannot be effectively handled by the United States unilaterally. Nevertheless, the time is ripe for a review of U.S. policies affecting energy technology, because such a review could contribute to the integration of policies and programs into a more coherent strategy.

CONTROLS ON NONNUCLEAR ENERGY EXPORTS

The Rationale of U.S. Export Controls

The U.S. system of export control attempts to balance two sometimes conflicting goals. These are preserving national security (by restricting the export of items that could significantly augment the military capabilities of unfriendly countries) and ensuring the ability of U.S. firms to export. In more concrete terms, the system is designed to identify and restrict U.S. exports that have military significance to particular countries, without constraining trade in other commodities and to other parts of the world. Sensitive exports that require extensive review and a validated license are contained on the Commodity Control List which includes more than 300 entries.[1] The U.S. system of export controls also includes a country classification of export destinations which reflect U.S. foreign policy considerations. Both the military significance of the particular commodity or technology and U.S. relations with the country to which the export is destined are taken into consideration in reviews of applications for export.

The rationale for U.S. export policies to China was summarized by President Reagan in a 1981 directive on technology transfer. It states that the United States "supports a secure, friendly and modernized China."[2] Earlier, the Carter Administration decided to liberalize exports of high technology civilian goods with potential military applications.

In the past 4 years, U.S. controls on exports to China have been rapidly liberalized. Under the "two times rule" adopted in 1981, exports with technical levels twice those previously exported to the U.S.S.R. and China were approved. In an even more dramatic move, China was transferred in June 1983, to category V, a catchall which includes friendly countries such as Japan and West European allies as well as Yugoslavia and India.[3] The United States also permits exports to China of items on the U.S. Munitions Control List on a case-by-case basis. These steps signaled that official U.S. policy sees China as a friendly country and seeks to promote its modernization.[4]

U.S. export administrators took an unusual step in establishing a "zone" system to cover China exports. The goal was to restrict certain kinds of exports in the interest of national security while speeding the review of applications for nonsensitive exports by providing clear guidelines to license review officers.

The China zone guidelines enable the Department of Commerce to expedite applications from U.S. businesses for "green" zone technologies that are seen to pose no threat to U.S. national security if exported.[5] Because of the time and technical effort required to formulate the zones, the Department of Commerce began by targeting seven areas for special attention in license reviews.[6] These seven categories, which were said to make up about 75 percent of all license applications for China,[7] were semiconductor production equipment; electronic instruments; microcircuits; computers; recording equipment; oscilloscopes; and computerized instruments. In the case of green zone items, the Department of Commerce can by itself approve exports.[8] U.S. export regulations include references to green zone items.

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[1] The entries are categorized by Export Commodity Control Numbers (ECCN) in the Department of Commerce Export Regulations.

[2] See Shelly Mumford, "U.S. Relaxes Restrictions on China Trade; Expects $2 Billion in Export Revenues," *EDN*, May 17, 1984, p. 301.

[3] In announcing this change, the U.S. Government noted that "restrictions on certain products and technologies" would nevertheless be allowed. See U.S. Department of Commerce, *Export Administration Annual Report, 1983* (Washington, DC: 1984), p. 9.

[4] See, for example, Department of State, "The U.S.-China Relationship," *Current Policy*, No. 594, May 31, 1984, p. 2. President Reagan directed in 1983 that China be treated as a "friendly, nonallied country."

[5] For a statement of the guidelines for U.S. controls on exports to China, see testimony of William T. Archey before the Subcommittee on International Economic Policy and Trade, House Foreign Affairs Committee, Nov. 17, 1983.

[6] Today there are eight major categories. Two of the orginal categories have been merged, and two additional ones added (microwave, numerically controlled machine tools).

[7] One expert has estimated that today the green zone actually covers about 40 to 50 percent of license applications.

[8] Some types of U.S. exports to China, such as agricultural products, do not require licenses or export review. In 1984, for example, total U.S. exports to China were valued at $3.0 billion ($1.9 billion in manufactured goods; $614 million for agricultural exports; $443 million other), while the total value of U.S. licenses approved for exports to China was $2.0 billion. This figure should, however, be used cautiously, since many export shipments may not actually occur or there may be delays between license approval and actual shipments. One expert in the U.S. Department of State estimates that only about 10 percent of all U.S. exports actually require extensive review.

The most advanced technologies that have direct applications to military systems are theoretically included in the "red" zone, although no list of red zone items has been published. Included are technologies with direct and significant military applications—nuclear weapons and delivery systems, technologies and equipment used in intelligence gathering, electronic warfare, antisubmarine warfare, power projection, and air superiority.[9] Some of these technologies could provide more significant military applications than some kinds of less sophisticated weaponry. Since the export of red zone technologies may pose a threat to U.S. national security, these license applications are carefully reviewed. Exports to China have been greatly liberalized in light of growing friendly relations, but militarily sensitive exports may be denied.

In practice, license reviews for all items not on the green list are approved on a case-by-case basis and require reviews by the Department of Defense and other agencies as appropriate. Initially it was hoped that a three zone system (red-intermediate-green) would clearly categorize all exports and facilitate reviews, but in actuality decisions about cases depend on a number of specific factors about which various executive branch agencies may disagree. Non-green zone exports may be approved if the agencies determine that their export causes no threat to U.S. national security. This determination is based on a number of factors. These include, among others, the type of end-user in China and the control that the U.S. firm will retain over the technology. In some cases, the reviewing agencies set conditions on exports (for example, that the equipment must be operated solely by the U.S. firm or that it be leased but not sold to China).

The categorization of items and technologies has evolved over time. For example, the United States restricts the export to China of computers with very high processing data rates (with processing data rates above 155 Mbits/second) on the grounds that they have significant military applications. The ceiling level has changed over time. In late 1984, after months of consideration, the U.S. Government approved the leasing of a high-powered Cyber computer to China. Both because U.S. policies toward China have changed and because technology is constantly being developed, the Commodity Control List and the zones must be periodically updated. (Technical Advisory Committees, which include industry representatives, help to identify the critical technical data in their fields.) At present, an interagency group is working on a review of the green zone (Green Zone II). This review has been underway for more than a year, much to the distress of exporters.

The total volume of trade with China has grown rapidly in the context of liberalization of export regulations. The dollar value of *all* approved licenses for export to China increased from $523 million in 1982 to $2 billion in 1984. According to one estimate, the "high-tech" exports (excluding commercial aircraft) exceeded $300 million of this total by 1984.[10] During 1984 of the 9,637 license applications processed, only 15 were denied. In addition, 1,810 were returned without action (often because forms were incomplete).

Because equipment used in energy development spans a number of Commodity Control List (CCL) categories, it is difficult to quantify the dollar value of these energy exports. In 1984 over $1 million worth of geophysical and mineral prospecting equipment and about $21,000 in nuclear related equipment was approved for export. The largest dollar value of approved exports ($1.1 billion) during 1984 was for "electric and electronic equipment."[11]

Under the current U.S. export system for China, there are very few nonnuclear energy-related exports considered to have direct military applications. Most energy-related commodities and technologies therefore are included in the green zone or require no license review.

The exceptions are high-powered computers and array transform processors used in oil and gas exploration, and certain kinds of calibration and measuring equipment. Because these kinds of equipment and technology are critical for some energy development projects such as offshore oil explorations, some U.S. energy technology transfers have been limited by these restrictions. Specifically, U.S. export controls do not permit sales of certain kinds of array processors used in evaluating seismic data in support of oil development.[12] U.S. export restrictions have been revised a number of times, with the result that U.S. firms such as Western Geophysical and Control Data Corp. have been forced to modify equipment. This is a costly process.[13] In addition, regulations on the export of technical data have been said to limit U.S. firms in providing training in analysis of seismic data.

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[9] See U.S. Department of State, "U.S. Export Controls and China," *GIST*, March 1985.

[10] Ibid.

[11] The Department of Commerce supplied these statistics to OTA in May 1985.

Problems With the System

U.S. controls on exports to China have been officially relaxed during recent years, but some uncertainty remains for exporters about what can and cannot be exported and how long the process of license review will take.[14] This uncertainty has been reflected in delays in license reviews, turf battles within and between U.S. agencies involved in export administration, difficulties in coordinating U.S. export policies with those of Japan and Western Europe, and (until recently) congressional stalemate over renewal of the Export Administration Act.

The number and dollar value of export applications for China more than doubled between 1983 and 1984 alone (see table 8). Not surprisingly, the U.S. export administration system has been unable to quickly respond to the surge in applications. Exporters have complained about delays associated with export licensing. Between June and October 1984, the licensing review process within the U.S. Government took an average of 117 days for green zone and 192 days for non-green zone case reviews. In addition, the required review by Cocom (discussed below) took about another 100 days in each case.[15]

Exporters and some U.S. Government officials claim that these delays have caused U.S. firms to lose sales. OTA has not been able to develop an estimate of lost sales, but U.S. firms probably have been disadvantaged in some cases because other supplier countries do not have such extensive export controls. Based on the information now available, however, it is not clear whether U.S. sales in energy-related fields would have been significantly higher had the delays been reduced since there are a number of other factors such as financing that come into play.

In addition to the backlog in license reviews, exporters complain about apparent inconsistencies in the system. For example, U.S. businessmen need approval to ship computers to their branches overseas; but they can often purchase the same computers abroad. U.S.-made advanced technology products such as computers are available throughout Asia and particularly in Hong Kong, China's second largest trading partner.

The Department of Commerce has taken a number of steps to streamline the review proc-

Table 8.—Export Applications for the PRC (millions)

	Received =	Pending +	Processed =	Approved +	Returned +	Denied
1983	4,015 ($1,300)	84	3,931	2,834	1,082	15
1984	9,637 ($6,300)	3,366	6,271	4,443	1,810	15
1985[a]	3,900 ($2,500)	NA	NA	1,800	NA	10

[a] First quarter 1985.

SOURCE: U.S. Department of Commerce, May 1985.

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[12] The current official green zone standard for array processors allows export of those that have a maximum rate of multiply operations less than or equal to 2 million per second or not less than 40 milliseconds for performing an FFT (fast fourier transformer) for 1,024 complex points. Industry officials note that there is no commercially available array transform processor that currently meets these specifications.

[13] According to one of the firms (Western Geophysical), the modifications (for eight array processors) cost $180,000. The total selling price of one of the processors is approximately $100,000. None of the eight units have yet been exported to China.

[14] In May and June 1985, OTA made a series of calls to Department of Commerce telephone numbers set up to provide exporters with information about the licensing system and the status of their application reviews. Out of 20 calls made to these numbers, the OTA call was answered only twice (and in both cases immediately put on hold). This admittedly limited experiment provides substantiation for claims that U.S. exporters find it extremely frustrating to obtain information about export administration.

[15] Data provided by DOC to OTA in May 1985.

ess. In May 1985 DOC officials stated that they were processing green zone cases within 30 days and that non-green zone case processing had probably been reduced to about 145 days. A Department of Defense official stated in June 1985 that they were processing cases in 18 to 20 days (average).

In addition to increasing the numbers of license reviewers, DOC officials point to specific steps taken to reduce the backlog in China applications. These include the elimination of end-user checks by other U.S. agencies for green zone applications; initiation of fast track processing by routing cases directly from the licensing division to the Cocom submission branch (eliminating review by the East-West trade office); using a form cover letter for submissions to Cocom; and automating some aspects of the licensing process.[16] Other steps taken (using faster means of sending submissions to Paris) were also expected to reduce the time required for Cocom review of U.S. cases.

DOC officials indicate that much of the backlog in Washington has been reduced and the review time significantly shortened. Whether this will continue and whether U.S. exporters, who have heard such promises by the DOC for years, will be satisfied remain to be seen.

Another type of problem concerns the definition of the green, intermediate, and red zones. The thrust of changes in U.S. controls on exports to China in recent years has been to focus attention on the really sensitive items (in the intermediate and red zones), while speeding the review of nonsensitive green zone items.

One dimension of this problem is that the zone definitions must be constantly updated, in light of technological change, foreign availability of items, and developments in U.S.-China relations. At a more fundamental level, disagreements about the zones reflect uncertainty about the national security implications of transferring certain types of technology to China. Official U.S. policy characterizes China as a friendly, non-allied country and export policy is to approve much more advanced and sensitive technology exports to China than to the Soviet Union. There is, however, room for disagreement among informed observers about what the proper threshold level should be and on what basis it should be determined.

Another question is whether sensitive (red zone) exports are slipping by U.S. license reviewers, either because of Chinese attempts to circumvent U.S. restrictions, or because license reviewers lack proper expertise and resources to evaluate export applications.

The first issue was raised in congressional hearings a few years ago. The Defense Intelligence Agency (DIA) in 1982 referred to an upsurge in Chinese attempts to obtain Western computers and other technologies restricted by Cocom through surreptitious efforts. The DIA Director, in congressional testimony, said that the Chinese Government did not appear to have a formal policy of illegal acquisition of restricted technologies, but it was "likely" using commercial channels and science and technology exchanges to supplement legitimate commercial purchases.[17] Other observers have suggested that China may use investments in the U.S. and dummy firms to gain access to U.S. technology.[18]

Questions about the capabilities of U.S. license reviewers, the second issue, have also been raised. A 1984 congressional hearing on technology transfer highlighted a turf battle between the Defense Department's DRE (Defense Research and Engineering) and ISP (International Security Policy).[19] More recently, Congress has debated the pros and cons of an expanded role for the Department of the Defense in Cocom.[20] The Department of Commerce and the Customs Service have, moreover, feuded over which has primary responsibilty for export enforcement. Bureaucratic struggles within U.S. export control agencies and between them revolve around who is best equipped to make technical judgments required in license review and whether reviewers have adequate resources to do a good job.

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[16] Department of Commerce officials also referred to the institution of simultaneous review by DOC and DOD of non-green zone cases. DOD officials stated that this had not been instituted.

[17] See Testimony of Lt. Gen. James A. Williams, DIA, before Subcommittee on International Trade, Finance, and Security Economics, Joint Economic Committee of the Congress, *Allocations of Resources in the Soviet Union and China*, June 29 and Dec. 1, 1982, p. 113. See also "U.S. to Ease Technology Controls, Change Country Group; August Announcement Seen," *U.S. Export Weekly*, June 28, 1983, pp. 463-464.

[18] Denis Fred Simon, "Technology for China: Too Much Too Fast?" *Technology Review*, October 1984, p. 48.

[19] Some Members of Congress questioned whether the more political ISP could effectively handle the technical review formerly led by DRE. This dispute was settled in favor of the ISP in the new Export Administration Act passed by both Houses in June 1985. See Senate Committee on Governmental Affairs, Subcommittee on Permanent Investigations, *Transfer of Technology*, hearings (Apr. 2, 3, 11, and 12, 1984) and report (September 1984), pp. 15 and 26. DOD officials in the Strategic Trade Directorate say that they call on the resources of DRE where needed in license reviews, and have available technical expertise throughout the Defense Deparment.

[20] See *Congressional Record*, May 9, 1985, H 3061.

Critics believe that the licensing bureaucracy was established to control exports and is not really committed to export liberalization. In addition, high-level policymakers have openly disagreed about U.S. export controls, thereby sending license examiners and exporters alike mixed signals. In this sense, the delays in the review process reflect underlying turf battles and differences in perspective among the relevant agencies. Congressional stalemate over renewal of the Export Administration Act reflected and contributed to these disputes. After 2 years of delay, Congress renewed the Export Administration Act on June 27, 1985, thereby sending a clearer signal to the executive branch on export controls which could help to moderate disputes among agencies over jurisdiction.

From one perspective, however, delays in license reviews may be a reasonable price to pay for ensuring that really sensitive technologies are not exported. On the other hand, delays may stem from negligence on the part of reviewers. The question is whether the process of export administration can be streamlined and, more importantly, whether a coherent strategy can be built to guide policy implementation.

Problems with export administration may be as serious (or perhaps more so) in Paris as in Washington. Paris is the headquarters of the Coordinating Committee for Multilateral Export Controls (Cocom), an informal organization involving the United States, Japan, and West European countries with the purpose of coordinating export policies toward Communist countries. A voluntary organization formed in 1950, Cocom operates on the basis of unanimous approval for decisions but has no formal sanctions against violations of its informal guidelines.

Cocom maintains three lists of items that exporters cannot sell to Soviet bloc countries (including China, Albania and Southeast Asian Communist countries) without its permission. These lists cover military, nuclear, and dual-use items. Despite its limited resources, Cocom remains one joint Western institution that keeps export controls on the multilateral agenda.

Because of U.S. membership in Cocom, U.S. export applications for sales of items on the Cocom list must pass Cocom review as well as U.S. review. Especially since U.S. controls on exports to China were loosened in 1983, the number of U.S. submissions (requests for approval by Cocom) has grown dramatically. In 1984 more than 2,200 U.S. license applications were sent to Cocom, while a total of more than 6,200 were processed in the United States.[21] The current Cocom system sets a voluntary framework that makes it difficult (but not "illegal") to make certain changes in U.S. export administration for China. Eliminating review of green zone exports to China altogether, for example, would not be likely so long as some of these items are covered by Cocom review. Nor is the United States likely under the current Cocom system to institute distribution licenses, which permit U.S. sellers to make repeated sales (unlimited quantities to unspecified end-users) during a specified time period.

While the details of Cocom decisionmaking are confidential, general problems have been much publicized. The major enduring dilemma is to maintain an operating consensus among Cocom members who often disagree about the details of export policy for specific Communist bloc countries. With regard to China specifically, the United States has found itself in the unusual position in recent years in its support of a liberalized Cocom review for China exports, while at the same time advocating tighter controls on exports to the Soviet Union. Countries such as France and West Germany have reportedly resisted these efforts in light of the fact that Washington has refused to loosen up on exports to countries such as Bulgaria where they do more business.[22]

Member countries have accused each other of playing "games" in Cocom designed to further the commercial fortunes of domestic firms. U.S. firms have complained that they have lost sales because of red tape and delays in Cocom review.[23] But firms from other countries have also complained that the United States uses Cocom to its own advantage.

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[21] Some of the license applications sent to Cocom cover two or more U.S. applications.

[22] See report by Stuart Auerbach, "Cocom Feuds Over Trade to East Bloc," *Wall Street Journal*, July 17, 1984, p. 27.

What is clear is that China applications make up by far the bulk of U.S. submissions to Cocom (90 percent),[24] and there have been many more U.S. submissions to Cocom than those by other Cocom members. According to one report, in early 1985 the United States had submitted 70 percent of all cases before Cocom: 807 of 877 pending cases were for products destined for China.[25] In May 1985 there was still a large backlog in Cocom cases, according to State and Commerce Department officials. Of the 454 U.S. cases pending in Cocom, 418 were for exports to China. In addition, more than 200 submissions had not been made because of a limitation that no more than 20 U.S. cases can be submitted weekly.[26] While data are not available on numbers of submissions by other Cocom countries, it appears that U.S. cases for China are still the great majority of cases now pending in Cocom, despite the fact that the value of U.S. exports is lower than that of Japan, for example.[27]

These problems have become points of contention in Cocom, and they have also been noted by the Chinese. The Chinese Vice Minister of the Ministry of Electronic Industry told a group of Seattle businessmen in April 1984 that Cocom approval was still a problem, despite the fact that the United States had relaxed its export regulations.[28] The Japanese *Mainichi Daily News* reported in March 1985 that Minister Ding Min of the Chinese Embassy in Tokyo called for Japanese efforts to remove China from the Cocom list.[29]

U.S. officials have disagreed among themselves about Cocom, and one high ranking trade official resigned in 1983 to protest what he called a "counterproductive" U.S. strategy in Cocom, specifically vis-a-vis controls on exports to the U.S.S.R. and Eastern Europe.[30] China-related exports are thus one facet of a larger Cocom consensus-building dilemma, but the surge in U.S. applications for China exports has certainly overwhelmed the organization.

Possible Improvements in U.S. Export Controls

The problems discussed above suggest a number of possible approaches to improving the U.S. system of export controls. Congress has, first of all, helped to clarify overall U.S. policy by passing an Export Administration Act. Failure to pass the act allowed export controls to be the product of bureaucratic rivalries within the executive branch. The recent passage of export control legislation holds at least the potential for reducing U.S. exporters' uncertainty about the system.

Nor does the U.S. Government possess extensive information about certain aspects of technology transfer to China, or to other parts of the world for that matter. More information and systematic review of alleged problems such as violations of U.S. export controls in third countries, and (if they occur) patent infringements and illegal acquisitions of technology by China could help to clarify where the real national security problems lie. Perhaps even more importantly, various agencies could cooperate better in exchanging relevant information.

There are a number of other possible steps which the executive branch might consider to improve the management of export adminstration, including concluding the Green Zone II review. The Department of Commerce has already added a number of people to its licensing review staff, but managerial improvements could also be made. License reviewers normally handle cases dealing with exports worldwide. It might be useful to assign a few individuals to concentrate on review of China cases, while preserving non-area expertise at higher decisionmaking levels. Measures to further automate the system of license review so that documents and information can be quickly exchanged among executive branch agencies could also help to streamline the U.S. export control process. In order to ensure that the really sensitive items are restricted, efforts could be made to further develop the technical expertise of license reviewers. For nonsensitive energy related exports, the ceiling on service supply licenses could be raised above the existing $8,000 limitation so as to facilitate exports.

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[23] See Stuart Auerbach, "Red Tape Snarls Seattle Exporter's Sale to China," *Washington Post*, July 22, 1984, p. F8.

[24] Data provided by DOC to OTA in May 1985.

[25] See Daniel Southerland and Stuart Auerbach, "High Tech Sales to China Delayed," *Washington Post*, Mar. 5, 1985, p. D1.

[26] Information provided to OTA by DOC, State, May 1985.

[27] It may be that other countries submit cases to Cocom only when a military end-user is involved or the item is clearly militarily sensitive. Cocom does not make public data that would make it possible to substantiate the hypothesis, but it seems unlikely that the United States is selling so many more items on the Cocom list than other countries.

[28] Stuart Auerbach, "China Hits Slowness of High Tech Imports," *Washington Post*, Apr. 24, 1984, p. D9.

[29] "Envoy Urges Removing PRC From Cocom List," *Mainichi Daily News* (English), Mar. 20, 1985, p. 1.

[30] See William A. Root, "Export Controls That Work," *Foreign Policy*, No. 56, fall 1984.

Efforts are now underway to streamline the Cocom process of China export reviews. Neither ending Cocom review of exports to China nor an aggressive unilateral U.S. push on Cocom partners to tighten controls is likely to be feasible or promising at this juncture. Instead, more constructive efforts are now being made to adopt a "notification" system for nonsensitive items. Cocom, with all its problems, is an organization that plays a key role in harmonizing Western approaches to East-West trade. It appears that changes can be made to streamline China review without jeopardizing the carefully built Cocom consensus on trade with other countries. In light of the informal nature of the Cocom organization, these steps can best be pursued in low-key negotiations among the member countries.

CONGRESSIONAL REVIEW OF NUCLEAR COOPERATION AGREEMENT

The primary focus of policy debate on nuclear-related matters will be on the proposed cooperation agreement with China. Issues of nuclear trade, proliferation, and strategic security are subsumed under this rubric. The specific issues are discussed in chapter 4. Additional information is in the Congressional Research Service Issue Brief included with the background papers.

Before a nuclear cooperation agreement becomes valid, it is submitted to Congress by the President for a period of 90 working days (30 days of consultation with the Foreign Affairs and Foreign Relations Committees, and 60 days of congressional review). If, as in this case, the President determines the agreement does not require an exemption from the relevant sections of the Atomic Energy Act as revised, the signed agreement comes into force at the end of the 90-day period, unless Congress adopts a joint resolution of disapproval. Congress would need a two-thirds majority to override a Presidential veto. Under the recently renewed Export Administration Act which was signed into law by the President on July 12, 1985, a nuclear agreement requiring an exemption because it significantly deviates from usual terms and conditions of the Atomic Energy Act would not be valid unless Congress passes a joint resolution approving it. The situation is less clear in the event that the President sends to Congress an agreement without exemption, but where one of the two lead committees believes an exemption is required. According to the conference committee that developed the legislation, in such a case Congress "expects that the President will submit an exemption."[31] There is, however, no specific requirement in the law to this effect.

When the U.S.-China agreement was submitted to Congress on July 24, 1985, it was accompanied by the President's written determination, approval and authorization for the agreement, a memorandum prepared jointly by the Departments of State and Energy stating that the agreement meets the requirements of U.S. law and that it serves U.S. foreign policy and nonproliferation interests, a memorandum from the Director of the Arms Control and Disarmament Agency (ACDA) assessing the "adequacy of the safeguards and other control mechanisms, and peaceful use assurances" of the proposed agreement, and a Nuclear Nonproliferation Assessment Statement prepared by ACDA.

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[31] Congressional Record, HR4919, June 25, 1985.

These documents are included at the back of this technical memorandum.

As Congress reviews the signed agreement the language of these documents (particularly Article 5 on retransfers and consent rights) will be carefully scrutinized. Concerns over possible improvements to submarine technology are more difficult to address via these documents, since the most likely route to enhanced capability would be through the upgrading of China's nuclear industry generally. Close monitoring as required by law of nuclear exports as part of the export control procedures handled by the Nuclear Regulatory Commission (NRC) and perhaps improved intelligence could also help to serve U.S. nuclear nonproliferation policy aims.

PROMOTING ENERGY TECHNOLOGY TRANSFERS

Limited Scope of U.S. Promotional Programs

The United States has few programs explicitly designed to promote commercial technology transfers to China. Official U.S. programs are focused much more on science and technical exchange than those of other countries like Japan where aid and official financing have been used extensively to support involvement in commercial energy development projects. In the United States, controls rather than promotional programs have been the central focus of policy debate.

There are a number of possible explanations for the comparative lack of attention to promotional measures. There may be a sense that U.S. promotional programs have not been especially effective in the past, or that these are best left to the firms themselves. In a period of budgetary austerity, it is unlikely that some of these programs will be expanded. Since U.S. controls are seen by many to directly inhibit trade, many proponents of expanded trade and technology transfer to China look to changes in export administration, rather than promotional programs, as the prime avenue for policy change.

The few U.S. Government programs that even indirectly affect commercial energy technology transfer to China include science and technology cooperation, U.S. official representation in China, and insurance and financing support for U.S. firms doing business there. The United States and China have established a Joint Commission on Commerce and Trade (JCCT), but current programs do not include activities in energy technology transfers.

Table 9 provides a listing of the energy-related science and technology accords. The fossil energy protocol was recently negotiated.[32]

The United States has assisted China's petroleum geologists by providing Landsat remote sensing data. The United States and China have also agreed to cooperate in environmental protection, but little has yet been done in the area of pollution control technologies. Studies on the health effects of coal combustion (at least one underway and others planned by the U.S. Department of Health and Human Services) could lay the foundation for exploring and documenting some very serious problems associated with energy use in China.[33]

Table 9.—Energy-Related Science and Technology Agreements With China

1. Nuclear Safety (NRC)
2. Nuclear Physics and Magnetic Fusion (DOE)
3. Fossil Energy (DOE)
   (Hydropower—expired)

NOTE: These agreements support basic science and exchange of information between scientists and technicians. The programs contribute, but rather indirectly, to commercial technology transfers in energy-related fields.

The hydropower protocol was probably the most controversial. U.S. private sector firms criticized the role of the U.S. Government, and there was some misunderstanding with the Chinese on the role of the private sector. See, for example, Robert A. Delfs, Jr., "Hydropower Agreement Update," *China Business Review*, May-June 1981, p. 52.

The U.S. Department of the Interior is continuing to provide technical assistance for Chinese hydropower development on a reimbursable basis. In other words, the Chinese are funding these studies, some of which have been subcontracted to U.S. firms. The Department of the Interior is leading discussions to explore the possibility of an expanded U.S. role in the Three Gorges Project, with U.S. private sector participation.

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[32] Among the 24 active protocols are agreements on cooperation in high energy physics, nuclear safety. See Department of State, "U.S.-China Science and Technology Exchanges," *GIST*, April 1985.

[33] See House Committee on Energy and Commerce, Special Subcommittee on U.S. Trade with China, *China's Economic Development and U.S. Trade Interests*, May 1985, pp. 49-52.

The U.S. Embassy in Beijing has a staff of 124 U.S. citizens, and another 50 are stationed in U.S. consulates in other cities. In order to represent U.S business, the Foreign Commercial Service has six U.S. officers stationed in China.[34] In addition, there are four[35] official U.S. representatives in Beijing involved in science and technology exchange activities.

U.S. Government financing and insurance programs supporting energy development in China have been fairly limited. The primary mechanisms for providing this support are loans and credits from the Export-Import Bank, insurance by the Overseas Private Investment Corporation (OPIC), and financing of feasibility studies by the Trade and Development Program. OPIC insures U.S. firms investing overseas; it covered three energy projects in China by September 1984.[36] U.S. direct investment in China is very limited.[37] OPIC insures against political risk, an important concern for U.S. firms participating in offshore oil and gas development. But limitations on OPIC's resources have been criticized by U.S. energy firms who believe that the ceiling on OPIC country coverage should be raised to support additional U.S. investments in Chinese energy devlopment.[38] The Chinese have found financing (some at aid-related concessional rates) from Japanese and other sources at interest rates lower than those offered by the U.S. Export-Import Bank. U.S. Export-Import Bank loans have been granted to only two U.S. firms involved in work in China. The two are Combustion Engineering and Westinghouse, involved in energy-related projects. Table 10 provides a list of the U.S. Government supported energy-related projects in China.

Subsidized supplier government financing has been a key factor in some of China's energy projects, particularly those in the hydroelectricity field. A number of these projects involve the use of "mixed credits," which combine official (Export-Import Bank) and aid-type concessional financing. The United States, because it does not have an aid program in China,[39] has not been in a position to match the soft financing offered elsewhere. The United States has used the Trade and Development Program, however, to provide financing for feasibility studies for one Chinese hydropower project (see table 10).

Japan, in contrast, negotiated with China a package of construction projects valued at $1.5 billion, one involving hydroelectricity development. The loans for these projects were provided by the Japanese Government, through the Overseas Economic Cooperation Fund which provides aid-type concessional financing at a rate of 3 percent annual interest over a 30-year repayment period. The Wuqiangxi hydroelectric powerplant supported by these loans is expected to power the refining of nonferrous metals, whose export should help finance Chinese purchases of Japanese products.[40] Japan's Export-Import Bank has also provided credits for seven coal development projects, and in 1983 it was said to have committed over $500 million to Chinese offshore oil development.[41] Table 11 shows that the Japanese Export-Import Bank has provided more than $2 billion for energy projects in China. Japan has

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[34] The total number of U.S. citizens officially posted to China is 178, including Foreign Commercial Service, State Department, United States Information Service, and other agency representation. These figures were provided by the U.S. State Department, May 1985, and the FCS, August 1985.

[35] In June 1985 there were three representatives, with an additional one authorized.

[36] See Henry R. Berghoef, "OPIC in China," *The China Business Review*, October 1984, p. 44.

[37] The most recent official U.S. Department of Commerce data show a negative U.S. foreign direct investment position of $9 million as of 1983. This statistic reflects the fact that the value of the debt owed by U.S. parent companies to their Chinese affiliates was greater than the debt owed by those affiliates to them. This is not uncommon in a situation where there is little or no direct investment by the parent firms.

New data will be released near the end of 1985. The U.S.-China Trade Council has drawn up a list of U.S.-PRC joint ventures (as of Mar. 31, 1985) that includes 17 in energy-related fields.

[38] See House Committee on Energy and Commerce, Special Subcommittee on U.S. Trade with China, *China's Offshore Oil Development and the Energy Security of the Pacific Rim*, Feb. 28, 1984, p. 56.

[39] Chapter 3, Section 620-F of the Foreign Assistance Act of 1961 prohibits the provision of funds (for aid) to Communist countries and stipulates that the President shall not waive this prohibition unless he can show that this is necessary for national security or that the country is no longer controlled by the international Communist conspiracy, or that assistance will promote its independence from such. The People's Republic of China is specifically mentioned. In recent years, the U.S. Government has provided some assistance through the TDP (Trade and Development Program) and through exchange programs, neither of which involve direct payments to China.

[40] See Chae-Jin Lee, *China and Japan* (Stanford, CA: Hoover Press, 1984), ch. 4.

[41] See Martin Weil, "Coal's Promises and Problems," *China Business Review*, March-April 1984.

Table 10.—U.S. Government-Supported Energy Department Projects in China

Project		
1. Dresser Ind., Inc.	oil/gas services	\$ 4,950,000[a]
2. Pennzoil Co.	oil/gas exploration	\$100,000,000[a]
3. Texaco Inc.	oil/gas exploration	\$ 50,000,000[a]
4. Combustion Eng.	thermal power generation	\$ 23,000,000[b]
5. Westinghouse	thermal power generation	\$ 28,000,000[b]
6. Harza Eng.	Tienshengqiao hydropower	\$ 440,000[c]
7. Not yet contracted	Hualing coal mine	\$ 550,000[c]
8. Kaiser Engineers	Yuxian coal gas	\$ 750,000[c]
9. SAIC	ShanJiasi heavy oil	\$ 280,000[c]

[a] Total insured investment by OPIC.
[b] Total loans by Export-Import Bank.
[c] Funds provided by the Trade and Development Program for feasibility studies.

NOTE: TDP supported pre-feasibility study exchanges between the Army Corps of Engineers and the Bureau of Reclamation on hydropower projects in China 1980-84.

SOURCE: Office of Technology Assessment.

Table 11.—U.S. and Japanese Trade, Aid, and Investment in China, 1983

	United States	Japan
Trade		
Exports to PRC	\$2,173 million	\$4,914 million
Imports from PRC	\$2,243 million	\$4,843 million
Investment	a	a
Aid (ODA loans net)	0	\$ 299 million[b]
ExIm loans for energy projects (1980-84)	\$ 51 million[c]	\$2,132 million[c]

[a] Official DOC data show a − \$9 million U.S. direct investment position in China during 1983. See footnote 42 for additional explanation. Additional data are now being prepared which may show a positive investment position for the United States in the hundreds of millions of dollars. The U.S. Department of State estimates that U.S. direct investment totaled more than \$100 million by late 1984. See Office of Chinese Affairs, USDOS, "U.S. and Other Foreign Investment in China," October 1984.

JETRO data indicate that Japan's direct investment position was \$2.9 million in 1983, and that by 1985 Japanese investments in China had risen to \$187 million.

[b] Total ODA received by China during 1983 was \$500 million. See OECD, *Geographical Distribution of Financial Flows to Developing Countries, 1980-83* (Paris: 1984), p. 74.

[c] See table 3 for U.S. data. Japanese data from JETRO data file 1984, provided to OTA. Japanese data includes only coal and oil development projects.

signed long-term agreements to import some of the coal and oil it is helping China develop, and has granted China trade preferences under the Generalized System of Preferences.

Japanese firms and the government work together to negotiate large development projects in China, which combine trade and aid concerns. While Japanese foreign direct investments in China are apparently very limited,[42] Japanese firms are well represented in China, including remote areas of the countryside, by trading companies as well as government organizations such as JETRO (the Japan External Trade Organization). In 1983, more than 1,200 Japanese experts were sent to China by JICA (the Japan International Cooperation Agency) to work on technical cooperation projects.[43] European firms are also pursuing innovative approaches to the China market. The establishment of a special West European financing consortium for China trade was recently announced.

Japan and the United States have developed quite different types of economic interactions with China. Table 11 shows the comparative strength of Japanese Government financing and aid as well as the strong overall lead Japanese firms enjoy in trade.

It is unlikely that the U.S. Government will provide subsidized financing for China trade equivalent to Japan's. Nor is it clear that this would be desirable from a national perspective, since the interest rate subsidies could be costly. The United States has furthermore gone on record advocating the elimination of mixed credits (which combine concessional aid and official trade financing) as examples of predatory financing.

On the other hand, the United States is well positioned to do much more in the area of promotion. Such steps could involve expansion of established programs, particularly support for feasibility studies and insurance programs. In addition, technical exchanges in areas such as reducing coal-related environmental pollution could be promoted under the science and technology protocols. This could be carried out by allocating funds directly to the projects rather than relying on the Environmental Protection Agency or some other government agency to provide funding. It should be noted that promotional programs could be expanded without adopting predatory financing approaches that weaken international trade agreements. The expansion of technical exchanges, Ex-Im financing and OPIC insurance and feasibility studies could all be carried out in a way consistent with international trade norms.

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[42] As indicated in the notes to table 11, investment data for China should be treated with great caution. Current official U.S. data is not available, and the U.S., Chinese, and Japanese governments include different elements in their foreign direct investment data.

[43] MITI, *Keizai Kyoryoku no Genjo to Mondai* (The Current Status of Economic Cooperation).

Selection of Energy Development Projects

Among the many energy development projects that China undertakes, some will undoubtedly be more successful than others. If there are negative side effects (such as adverse environmental consequences) associated with technology transfers, ill will might be created between the United States and China.

But while energy technology transfers to China could involve negative, unexpected consequences for both countries, the U.S. Government has not and probably cannot establish regulations that eliminate such risks. The one important exception to this rule is national security-related risks, where the U.S. export control system is designed to prohibit certain types of transfers with potential military applications. In particular, nuclear-related exports must undergo an extensive review by the Department of Energy and related agencies.

With regard to the other nonsensitive energy technologies, the ability of the U.S. Government to try to tell China how to develop its energy resources is quite limited. The U.S. Government officially supports few energy-related projects in China, as table 10 indicates. In addition, given the availability of energy technologies from other suppliers it generally would be futile for the United States to try to tell China what to purchase. The basic assumption of U.S. policies affecting technology transfers worldwide is that the firms themselves are in a position to make responsible choices about what kinds of technology transfers they should make, unless these choices impinge on national security. In addition, since the United States does not have an aid program for China, a mechanism for encouraging certain types of projects in developing countries is not available for China.

In the few instances where U.S. Government financing is used (Ex-Im Bank loans and credits), the Ex-Im Bank considers the creditworthiness of the host country. Today China is ranked high in terms of creditworthiness by the Bank.[44] Project selection by the Bank normally involves an evaluation of the financial soundness of the proposed project. The Bank prefers projects that will expand U.S. exports and employment. The Bank, however, does not have a rigid set of criteria used in evaluating projects, and in practice decisions have often been influenced by political factors.[45]

Since 1977, Congress has reviewed nuclear technology exports involving financing by the Bank. The level of loans and credits for nuclear-related exports has fallen in recent years to 2.4 percent ($4 million to support management services) of the Bank's authorizations in energy-related products and services in 1983.[46] The Bank has changed its position in recent years on support of nuclear exports to countries such as Egypt, reflecting controversy within the United States over whether or not subsidized financing should be provided to such projects. In practice, however, Ex-Im Bank financing for nuclear projects has fallen to a very small part of Bank-supported projects. For China, Ex-Im financing of nuclear exports will be moot until the agreement on nuclear cooperation becomes effective.

The Overseas Private Investment Corporation, which provides investment insurance, contractor guarantees, and other support to U.S. investments overseas has a detailed and extensive list of criteria it considers when supporting a project.[47]

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[44] Information provided to OTA by U.S. Export-Import Bank in May 1985.

[45] See, for example, "The Selection and Distribution of Loans," in Richard E. Feinberg, *Subsidizing Success: The Export-Import Bank in the U.S. Economy* (Cambridge, MA: Cambridge University Press, 1982), p. 65.

[46] Export-Import Bank, *Report to the Congress on Export Credit Competition and the Export-Import Bank of the United States*, for Jan. 1, 1983 to Dec. 31, 1983 (Washington, DC: 1984).

[47] For a discussion of OPIC's role in technology transfer, see U.S. Congress, Office of Technology Assessment, *Technology Transfer to the Middle East* (Washington DC: U.S. Goverment Printing Office, September 1984), OTA-ISC-173, p. 538ff.

Congress requires that OPIC carry out a developmental impact statement of projects, in order to ensure that economic and social effects are taken into account. Other criteria considered include U.S. employment, technology transfer, productivity, multiplier effects on other industries, contribution to host country revenues, and environmental and safety effects.

It does not appear likely that the U.S. Government could effectively extend its review of energy projects beyond what is already built into these reviews and into export administration review (on grounds of U.S. national security).

On the other hand, more could be done to provide China with information on the health and safety effects of energy technologies. There are protocols with China in environmental protection and nuclear safety. But science and technology exchanges in these and other areas (legal issues surrounding contract obligations, and project management) could be enlarged to augment China's own expanding efforts in the area of environmental protection.[48]

Possible Improvements in U.S. Promotional Programs

While controls remain the major focus of U.S. Government policies affecting technology transfers to China, there are steps that could be taken to promote energy technology transfers in addition to streamlining the license review process.

At the most general level, Congress could take the lead in promoting a new view of the United States as a country whose economic health depends on our ability to promote exports worldwide. This would involve a significant change in thinking in light of recent preoccupation with import penetration. It is unlikely that promotional programs will be expanded unless Congress develops a new approach to U.S. exports. More extensive export promotion programs could be designed that support rather than endanger multilateral agreements on trade and export financing.

There is no one program that if changed or enlarged would provide a "quick fix" for export promotion, but there are a number of possibilities for incremental improvements, particularly in information flows. U.S. representation through the Foreign Commercial Service could be expanded in China, and efforts could be better linked to trade development in the United States. Such efforts could, in some cases, augment the science and technology protocol activities. The U.S. Government could support expanded technical training in energy-related fields in China and in the United States. Were the United States to establish an aid program, more extensive programs could be considered, but the above-mentioned steps could be taken regardless.

In the absence of an aid program, science and technology exchanges are a major avenue for U.S. Government support. Protocols in fossil energy and nuclear safety provide a framework for cooperation in energy-related fields. Programs of the Committee on Scholarly Communication with the People's Republic of China (CSCPRC) under the National Academy of Sciences and the National Academy of Engineering, funded by U.S. Government agencies, support exchanges of scholars between the United States and China in the engineering and social science fields relevant to energy technology transfer. The joint study on coal conversion in China supported by the CSCPRC is an example of a useful exchange of information that should assist both Chinese and U.S. firms in this field of energy development. Further studies and exchanges in energy-related fields could be considered, but their relevance and utility will also depend on the support given these efforts by China's leaders.

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[48] See "Chinese Environmental Protection: The Regulatory Climate," *China Business and Trade*, vol. vi, issue 22, May 23, 1985.

BALANCING CONTROL AND PROMOTION

U.S. Government policies and programs affecting energy technology transfers to China include a mix of controls and promotional programs that has shifted over time in response to changes in overall U.S. China policy and other contextual factors. While export controls retain a central place in U.S. policies, today agreements for cooperation in science and technology as well as limited financial and insurance support provide only modest encouragement for technology transfer in energy fields.

Despite the problems identified above, the fundamental rationale for export controls remains valid. U.S. export controls play a critical role in restricting the flow of militarily sensitive technologies while at the same time allowing exports in other areas. A U.S.-led push to remove exports to China from Cocom review is not at present a feasible or promising alternative, since this would greatly reduce the ability of Western countries to control exports in the event that China dramatically changes its foreign policy, and since removing China from Cocom could disturb the voluntary consensus that undergirds the organization.

Nevertheless, much could be done to streamline and improve the system. In addition, as technology is further developed and U.S.-China relations evolve, it will be important to review periodically the overall balance of control and promotion programs to ensure a proper fit with overall U.S. China policy. This type of systematic review is especially needed at this point, since U.S.-China economic relations have developed rapidly during the past few years.

Many of the areas where improvements could be made in U.S. policies are not easily susceptible to congressional action, and many require multilateral coordination with other countries. The following types of changes could be considered:

- measures to improve the efficiency of the U.S. export control system (upgrading the technical expertise of license examiners, expanding their numbers, better management of license review, better coordination among executive branch agencies involved in the review);
- measures to speed the Cocom review process (adoption of a "notification" system for nonsensitive exports so that Cocom review can focus on the really sensitive cases while at the same time keeping a record of other types of exports that can be periodically reviewed); and
- maintain and expand promotional measures (use science and technology exchanges to assist China in understanding the long-term environmental effects of energy technology transfers; maintain financing and other supports for energy projects such as measures to improve the flow of information about China's technology needs and U.S. expertise).

Congress has an immediate role in reviewing the nuclear cooperation agreement. Although it does not specifically promote exports, an agreement is a necessary step for expanding nuclear trade. However, there are other factors that Congress will consider in this review: nonproliferation policy, the adequacy of the consent rights provisions, the level of concern over potential improvements to China's nuclear submarines, the appropriateness of nuclear power for China, the role of other supplier countries, and overall U.S.-China relations. As discussed in chapter 4, different evaluations of these factors can lead to arguments favoring or rejecting the agreement.

China's energy technology requirements present a tremendous opportunity for U.S. firms and organizations. U.S. technologies could, in particular, contribute to improving the efficient use of energy, environmental protection, and the development of large-scale electrical systems in China. While there are significant risks associated with energy technology transfers, the potential gains outweigh the dangers and it should be possible to effectively manage the risks.

U.S. policies affecting energy technology transfers, however, have been rather inconsistently implemented to date. Despite high-level decisions to liberalize exports, uncertainty and delays have continued within U.S. export administration. U.S. Government policymakers must maintain the proper balance between controls and promotional policies, one consistent with the overall U.S.-China relationship. In the current context, the major challenges are to further focus attention of export examiners on assessing, limiting, and monitoring the militarily sensitive exports, while expanding efforts to promote the many other types of energy technology transfers China needs to develop its energy resources.

Appendix

Nuclear Cooperation Agreement and Supporting Documents

Appendix

Nuclear Cooperation Agreement and Supporting Documents

Agreement for Cooperation Between The Government of the United States of America and The Government of the People's Republic of China Concerning Peaceful Uses of Nuclear Energy

The Government of the United States of America and the Government of the People's Republic of China,

Desiring to establish extensive cooperation in the peaceful uses of nuclear energy on the basis of mutual respect for sovereignty, non-interference in each other's internal affairs, equality and mutual benefit,

Noting that such cooperation is one between two nuclear weapon states,

Affirming their support of the objectives of the statute of the International Atomic Energy Agency (IAEA),

Affirming their intention to carry out such cooperation on a stable, reliable and predictable basis,

Mindful that peaceful nuclear activities must be undertaken with a view to protecting the international environment from radioactive, chemical and thermal contamination,

Have agreed as follows:

Article 1
Definitions

For the purposes of this agreement:

(1) "parties" means the Government of the United States of America and the Government of the People's Republic of China;

(2) "authorized person" means any individual or any entity under the jurisdiction of either party and authorized by that party to receive, possess, use, or transfer material, facilities or components;

(3) "person" means any individual or any entity subject to the jurisdiction of either party but does not include the parties to this agreement;

(4) "peaceful purposes" include the use of information, technology, material, facilities and components in such fields as research, power generation, medicine, agriculture and industry but do not include use in, research specifically on or development of any nuclear explosive device, or any military purpose;

(5) "material" means source material, special nuclear material or byproduct material, radioisotopes other than byproduct material, moderator material, or any other such substance so designated by agreement of the parties;

(6) "source material" means (i) uranium, thorium, or any other material so designated by agreement of the parties, or (ii) ores containing one or more of the foregoing materials, in such concentration as the parties may agree from time to time;

(7) "special nuclear material" means (i) plutonium, uranium 233, or uranium enriched in the isotope 235, or (ii) any other material so designated by agreement of the parties;

(8) "byproduct material" means any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material;

(9) "moderator material" means heavy water, or graphite or beryllium of a purity suitable for use in a reactor to slow down high velocity neutrons and increase the likelihood of further fission, or any other such material so designated by agreement of the parties;

(10) "high enriched uranium" means uranium enriched to twenty percent or greater in the isotope 235;

(11) "low enriched uranium" means uranium enriched to less than twenty percent in the isotope 235;

(12) "facility" means any reactor, other than one designed or used primarily for the formation of plutonium or uranium 233, or any other item so designated by agreement of the parties;

(13) "reactor" is defined in Annex I, which may be modified by mutual consent of the parties.

(14) "sensitive nuclear facility" means any plant designed or used primarily for uranium enrichment, reprocessing of nuclear fuel, heavy water production or fabrication of nuclear fuel containing plutonium;

(15) "component" means a component part of a facility or other item, so designated by agreement of the parties;

(16) "major critical component" means any part or group of parts essential to the operation of a sensitive nuclear facility;

(17) "sensitive nuclear technology" means any information (including information incorporated in a facility or an important component) which is not in the public domain and which is important to the design, construction, fabrication, operation or maintenance of any sensitive nuclear facility, or such other information so designated by agreement of the parties.

Article 2
Scope of Cooperation

1. The parties shall cooperate in the use of nuclear energy for peaceful purposes in accordance with the provisions of this agreement. Each party shall implement this agreement in accordance with its respective applicable treaties, national laws, regulations and license requirements concerning the use of nuclear energy for peaceful purposes. The parties recognize, with respect to the observance of this agreement, the principle of international law that provides that a party may not invoke the provisions of its internal law as justificaton for its failure to perform a treaty.

2. Transfers of information, technology, material, facilities and components under this agreement may be undertaken directly between the parties or through authorized persons. Such cooperation shall be subject to this agreement and to such additional terms and conditions as may be agreed by the parties.

3. Material, facilities and components will be regarded as having been transferred pursuant to this agreement only upon receipt of confirmation by the supplier party, from the appropriate Government authority of the recipient party, that such material, facilities or components will be subject to this agreement and that the proposed recipient of such material, facilities or components, if other than the recipient party, is an authorized person.

4. Any transfer of sensitive nuclear technology, sensitive nuclear facilities, or major critical components will, subject to the principles of this agreement, require additional provisions as an amendment to this agreement.

Article 3
Transfer of Information and Technology

Information and technology concerning the use of nuclear energy for peaceful purposes may be transferred. Transfers of such information and technology shall be that which the parties are permitted to transfer and may be accomplished through various means, including reports, data banks, computer programs, conferences, visits and assignments of persons to facilities. Fields which may be covered include, but shall not be limited to, the following:

(1) research, development, experiment, design, construction, operation, maintenance and use and retirement of reactors and nuclear fuel fabrication technology;

(2) the use of material in physical and biological research, medicine, agriculture and industry;

(3) nuclear fuel cycle research, development and industrial application to meet civil nuclear needs, including multilateral approaches to guaranteeing nuclear fuel supply and appropriate techniques for management of nuclear wastes;

(4) health, safety, environment, and research and development related to the foregoing;

(5) assessing the role nuclear power may play in international energy plans;

(6) codes, regulations and standards for the nuclear energy industry; and

(7) such other fields as may be agreed by the parties.

Article 4
Transfer of Material, Facilities and Components

1. Material, facilities and components may be transferred pursuant to this agreement for applications consistent with this agreement. Any special nuclear material to be transferred under this agreement shall be low enriched uranium except as provided in paragraph 4 of this article.

2. Low enriched uranium may be transferred for use as fuel in reactors and reactor experiments, for conversion or fabrication, or for such other purposes as may be agreed by the parties.

3. The quantity of special nuclear material transferred under this agreement shall be the quantity which the parties agree is necessary for any of the following purposes: the loading of reactors or use in reactor experiments, the efficient and continuous operation of such reactors or conduct of such reactor experiments, and the accomplishment of such other purposes as may be agreed by the parties.

4. Small quantities of special nuclear material may be transferred for use as samples, standards, detectors, targets, radiation sources and for such other purposes as the parties may agree.

Article 5
Retransfers, Storage, Reprocessing, Enrichment, Alteration, and No Use for Military Purposes

1. Material, facilities, components or special nuclear material transferred pursuant to this agreement and any special nuclear material produced through the use of such material or facilities may be retransferred by the recipient party, except that any such material, facility, components or special nuclear material shall not be retransferred to unauthorized persons or, unless the parties agree, beyond its territory.

2. Neither party has any plans to enrich to twenty percent or greater, reprocess, or alter in form or content material transferred pursuant to this agreement or material used in or produced through the use of any material or facility so transferred. Neither party has any plans to change locations for storage of plutonium, uranium 233 (except as contained in irradiated fuel elements), or high enriched uranium transferred pursuant to this agreement or used in or produced through the use of any material or facility so transferred. In the event that a party would like at some future time to undertake such activities, the parties will promptly hold consultations to agree on a mutually acceptable arrangement. The parties undertake the obligation to consider such activities favorably, and agree to provide pertinent information on the plans during the consultations. Inasmuch as any such activities will be solely for peaceful purposes and will be in accordance with the provisions of this agreement, the parties will consult immediately and will seek agreement within six months on long-term arrangements for such activities. In the spirit of cooperation the parties agree not to act within that period of time. If such an arrangement is not agreed upon within that period of time, the parties will promptly consult for the purpose of agreeing on measures which they consider to be consistent with the provisions of the agreement in order to undertake such activities on an interim basis. The

parties agree to refrain from actions which either party believes would prejudge the long-term arrangements for undertaking such activities or adversely affect cooperation under this agreement. The parties agree that the consultations referred to above will be carried out promptly and mutual agreement reached in a manner to avoid hampering, delay or undue interference in their respective nuclear programs. Neither party will seek to gain commercial advantage. Nothing in this article shall be used by either party to inhibit the legitimate development and exploitation of nuclear energy for peaceful purposes in accordance with this agreement.

3. Material, facilities or components transferred pursuant to this agreement and material used in or produced through the use of any material, facility or components so transferred shall not be used for any nuclear explosive device, for research specifically on or development of any nuclear explosive device, or for any military purpose.

Article 6
Physical Security

1. Each party shall maintain adequate physical security with respect to any material, facility or components transferred pursuant to this agreement and with respect to any special nuclear material used in or produced through the use of any material or facility so transferred.

2. The parties agree to the levels for the application of physical security set forth in Annex II, which levels may be modified by mutual consent of the parties. The parties shall maintain adequate physical security measures in accordance with such levels. These measures, as minimum protection measures, shall be comparable to the recommendations set forth in IAEA document INFCIRC/225/Revision 1 entitled "The Physical Protection of Nuclear Material", or in any revision of that document agreed to by the parties.

3. The parties shall consult at the request of either party regarding the adequacy of physical security measures maintained pursuant to this article.

4. Each party shall identify those agencies or authorities responsible for ensuring that levels of physical security are adequately met and having responsibility for coordinating response and recovery operations in the event of unauthorized use or handling of material subject to this article. Each party shall also designate points of contact within its national authorities to cooperate on matters of out-of-country transportation and other physical security matters of mutual concern.

Article 7
Cessation of Cooperation

1. Each party shall endeavor to avoid taking any actions that affect cooperation under this agreement. If either party at any time following entry into force of this agreement does not comply with the provisions of this agreement, the parties shall promptly hold consultations on the problem, it being understood that the other party shall have the rights to cease further cooperation under this agreement.

2. If either party decides to cease further cooperation under this agreement, the parties shall make appropriate arrangements as may be required.

Article 8
Consultations

1. The parties shall consult at the request of either party regarding the implementation of this agreement, the development of further cooperation in the field of peaceful uses of nuclear energy, and other matters of mutual concern.

2. The parties recognize that this cooperation in the peaceful uses of nuclear energy is between two nuclear-weapon states and that bilateral safeguards are not required. In order to exchange experience, strengthen technical cooperation between the parties,

ensure that the provisions of this agreement are effectively carried out, and enhance a stable, reliable, and predictable nuclear cooperation relationship, in connection with transfers of material, facilities and components under this agreement the parties will use diplomatic channels to establish mutually acceptable arrangements for exchanges of information and visits to material, facilities and components subject to this agreement.

3. The parties shall exchange views and information on the establishment and operation of their respective national accounting and control systems for source and special nuclear material subject to this agreement.

Article 9
Environmental Protection

The parties shall consult, with regard to activities under this agreement, to identify the international environmental implications arising from such activities and shall cooperate in protecting the international environment from radioactive, chemical or thermal contamination arising from peaceful nuclear cooperation under this agreement and in related matters of health and safety.

Article 10
Entry Into Force and Duration

1. This agreement shall enter into force on the date of mutual notifications of the completion of legal procedures by the parties and shall remain in force for a period of thirty years. This term

may be extended by agreement of the parties in accordance with their respective applicable procedures.

2. Notwithstanding the suspension, termination or expiration of this agreement or any cooperation hereunder for any reason, the provisions of articles 5, 6, 7, and 8 shall continue in effect so long as any material, facility or components subject to these articles remain in the territory of the party concerned or any material, facility or components subject to these articles remain subject to that party's right to exercise jurisdiction or to direct disposition elsewhere.

IN WITNESS WHEREOF, the undersigned, being duly authorized, have signed this agreement.

DONE at Washington this 23rd day of July, ~~1984~~ 1985, JSH
in English and Chinese, both equally authentic.

FOR THE GOVERNMENT OF THE
UNITED STATES OF AMERICA:
John S. Herrington

FOR THE GOVERNMENT OF THE
PEOPLE'S REPUBLIC OF CHINA:

Annex I -- Definition of "Reactor"

"Reactor" means:

1. any apparatus, other than a nuclear weapon or other nuclear explosive device, in which a self-sustaining fission chain reaction is maintained by utilizing uranium, plutonium or thorium, or any combination thereof; or

2. any of the following major parts of an apparatus described in paragraph 1:

   (1) a pressure vessel designed to contain the core;

   (2) primary coolant pumps;

   (3) fuel charging or discharging machines;

   (4) control rods.

A "reactor" does not include the steam turbine generator portion of a nuclear power plant.

Annex II

Pursuant to paragraph 2 of article 6, the agreed levels of physical security to be ensured by the competent national authorities in the use, storage and transportation of the materials listed in the attached table shall as a minimum include protection characteristics as below.

Category III

Use and storage within an area to which access is controlled.

Transportation under special precautions including prior arrangements among sender, recipient and carrier, and prior agreement between entities subject to the jurisdiction and regulation of supplier and recipient States, respectively, in case of international transport specifying time, place and procedures for transferring transport responsibility.

Category II

Use and storage within a protected area to which access is controlled, i.e., an area under constant surveillance by guards or electronic devices, surrounded by a physical barrier with a limited number of points of entry under appropriate control, or any area with an equivalent level of physical protection.

Transportation under special precautions including prior arrangements among sender, recipient and carrier, and prior agreement between entities subject to the jurisdiction and regulation of supplier and recipient States, respectively, in case of international transport, specifying time, place and procedures for transferring transport responsibility.

Category I

Material in this category shall be protected with highly reliable systems against unauthorized uses as follows:

Use and storage within a highly protected area, i.e., a protected area as defined for category II above, to which, in addition, access is restricted to persons whose trustworthiness has been determined, and which is under surveillance by guards who are in close communication with appropriate response forces. Specific measures taken in this context should have as their objective the detection and prevention of any assault, unauthorized access or unauthorized removal of material.

Transportation under special precautions as identified above for transporation of categories II and III materials and, in addition, under constant surveillance by escorts and under conditions which assure close communication with appropriate response forces.

Agreed Minute

During the negotiation of the Agreement for Cooperation between the United States of America and the People's Republic of China Concerning Peaceful Uses of Nuclear Energy signed today, the following understanding, which shall be an integral part of the agreement, was reached.

The parties agree that the interpretation and implementation of article 5(3) shall not involve any nuclear activities and related research and development carried out by either party, as a nuclear weapon state, through the use of material, facilities, components and technology not subject to the agreement.

TABLE: CATEGORIZATION OF NUCLEAR MATERIAL[e]

Material	Form	Category I	Category II	Category III
1. Plutonium[a,f]	Unirradiated[b]	2 kg or more	Less than 2 kg but more than 500 g	500 g or less[c]
2. Uranium-235[d]	Unirradiated[b]			
	– uranium enriched to 20% ^{235}U or more	5 kg or more	Less than 5 kg but more than 1 kg	1 kg or less[c]
	– uranium enriched to 10% ^{235}U but less than 20%	–	10 kg or more	Less than 10 k
	– uranium enriched above natural, but less than 10% ^{235}U	–	–	10 kg or more
3. Uranium-233	Unirradiated[b]	2 kg or more	Less than 2 kg but more than 500 g	500 g or less[c]

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[a] All plutonium except that with isotopic concentration exceeding 80% in plutonium-238.

[b] Material not irradiated in a reactor or material irradiated in a reactor but with a radiation level equal to or less than 100 rads/hour at one meter unshiel

[c] Less than a radiologically significant quantity should be exempted.

[d] Natural uranium, depleted uranium and thorium and quantities of uranium enriched to less than 10% not falling in Category III should be protected i accordance with prudent management practice.

[e] Irradiated fuel should be protected as Category I, II or III nuclear material depending on the category of the fresh fuel. However, fuel which by virtu original fissile material content is included as Category I or II before irradiation should only be reduced one Category level, while the radiation level f fuel exceeds 100 rads/h at one meter unshielded.

[f] The State's competent authority should determine if there is a credible threat to disperse plutonium malevolently. The State should then apply physi protection requirements for category I, II or III of nuclear material, as it deems appropriate and without regard to the plutonium quantity specified u each category herein, to the plutonium isotopes in those quantities and forms determined by the State to fall within the scope of the credible dispersa

Deputy Secretary of State
Washington, D.C. 20520

July 20, 1985

MEMORANDUM FOR: THE PRESIDENT

FROM: John C. Whitehead
John S. Herrington

SUBJECT: Proposed Agreement for Cooperation Between the United States and the People's Republic of China Concerning Peaceful Uses of Nuclear Energy

A proposed new agreement for peaceful nuclear cooperation between the United States and the People's Republic of China (PRC), including an accompanying agreed minute which is an integral part of the agreement, is at attachment 3. A summary of the basic provisions of the proposed agreement is at attachment 4.

The agreement was negotiated by the Department of State, with the technical assistance and concurrence of the Department of Energy and in consultation with the Arms Control and Disarmament Agency (ACDA), whose views and recommendations are at attachment 5. The Nuclear Proliferation Assessment Statement concerning the agreement is being submitted to you directly by the Director of ACDA.

The agreement was initialed in Beijing on April 30, 1984. While recent amendments to section 123 of the Atomic Energy Act would permit you to transmit the agreement to Congress for "consultations" before the agreement had been signed, we recommend that you approve the agreement, authorize it for signature, determine that it will promote, and not constitute an unreasonable risk to, the common defense and security and have the agreement signed before it is transmitted to Congress. If you approve our recommendation, the agreement will be signed and then transmitted to Congress for 90 days of continuous session. If you agree with our conclusion that the agreement meets all the applicable requirements of the Atomic Energy Act of 1954, as amended by the Nuclear Non-Proliferation Act of 1978, it may be transmitted to Congress without an exemption of any of those requirements. An agreement without exemptions may be brought into force after 90 days of continuous session unless, during that time, there has been enacted a joint resolution of disapproval (which would require presentation to you for signature or veto).

The Nuclear Non-Proliferation Act of 1978 (NNPA) contains requirements for new or amended agreements for peaceful nuclear cooperation. In our judgment, the proposed agreement meets all the requirements applicable to such agreements with nuclear-weapon states. It is the first peaceful nuclear cooperation agreement with a Communist country and the only such agreement applicable solely to another nuclear-weapon state (the UK and France are covered by U.S. agreements with EURATOM).

China intends to make nuclear power one of its major energy sources by the year 2000. China has announced plans to build, by that year, nuclear power plants with a total capacity of 10,000 MWe. In the first stage of development, the PRC plans to build a Chinese-designed, 300 MWE reactor at Qinshan, Zhejiang (near Shanghai). China also plans on the construction of two much larger reactor projects: the twin 1000 MWe "Sunan" plant, to be built in Southern Jiangsu Province; and the Daya Bay, Guangdong plant, to include twin 900 MWE reactors. China is negotiating with a number of countries for assistance to its program, but it is clear that China regards U.S. nuclear equipment and technology very highly and would like to be able to buy such equipment and technology from the United States.

The purpose of the agreement is to permit such peaceful nuclear cooperation to take place between the United States and the PRC. It has a term of 30 years, subject to extension by the parties in accordance with their respective requirements, and provides for the transfer of facilities (including reactors), components and material (including fuel) for both nuclear research and power purposes. The agreement does not provide for any transfer of sensitive nuclear technology, sensitive nuclear facilities or major critical components.

The agreement contains provisions which satisfy the requirements of section 123 a. of the Atomic Energy Act as they apply to nuclear-weapon states. Paragraph (1) of section 123 (a) requires that safeguards "as set forth in the agreement" will be maintained for the life of items subject to the agreement, irrespective of the duration of the agreement itself. Under the Nuclear Non-Proliferation Treaty and section 127 (1) of the Atomic Energy Act, International Atomic Energy Agency (IAEA) safeguards are only required as a condition for nuclear exports to non-nuclear-weapon states. Therefore, IAEA safeguards are not provided for in the agreement. Article 8 (2), however, provides for arrangements for exchanges of information and visits by U.S. Government officials to material, facilities and components subject to the agreement. Mutually acceptable arrangements on such visits and information exchange will be established prior to the approval of any U.S.

exports under the agreement. This provision, together with article 10 (2), which provides that this provision and others continue for the life of the items to which they apply, meets the requirement of section 123 (a) (1).

Legally required provisions precluding retransfers without U.S. consent and precluding any military or explosive use are contained in article 5 (1) and (3). The required provisions on the physical protection of items subject to the agreement are in article 6. Paragraphs (2) and (4) of section 123 (a) of the Atomic Energy Act, pertaining to IAEA safeguards on all nuclear activities and a right of return of items in certain circumstances, do not by their terms apply to agreements with nuclear-weapon states, and consequently are not reflected in the U.S.-PRC agreement.

Subsections 123 (a) (7) and (8) of the Atomic Energy Act require that the U.S. have prior approval rights with regard to reprocessing, enrichment, alteration in form and content and (for weapons-usable material) storage of material subject to the agreement. These requirements are met in article 5 (2) of the agreement, although the text of this provision is different from the formulations in previous agreements. The effect of the provision is that none of these activities may be undertaken unilaterally; prior approval of the United States is required.

In accordance with section 407 of the Nuclear Non-Proliferation Act, the agreement contains a provision relating to identification of environmental implications and protection of the international environmental aspects of activities under the agreement, and in related matters of health and safety.

The proposed agreement will, in our view, further the non-proliferation and other foreign policy interests of the United States. During the period of our negotiations, China took several important steps which clarify its non-proliferation and nuclear export policies and practices. Chinese Premier Zhao made important statements of China's non-proliferation policy which make clear that China will not contribute to proliferation. The Premier's statements were subsequently endorsed by the National People's Congress, thereby giving them official status. In conjunction with China's membership in the International Atomic Energy Agency effective January 1, 1984, China said that it will require safeguards on its future nuclear export commitments to non-nuclear weapon states and is implementing that policy.

Entry into force of this agreement will provide a framework for a continuation of our discussions on non-proliferation matters with the Chinese. It also will have a significant, positive impact on overall U.S.-China relations, and thus will promote important U.S. foreign policy interests. It will also provide U.S. companies an opportunity to participate in another aspect of China's energy program with possibly substantial economic benefit.

We believe the proposed agreement, including the agreed minute, meets all statutory requirements. It will also serve United States non-proliferation and other foreign policy interests. Therefore, pursuant to section 123 (b) of the Atomic Energy Act, as amended, we recommend that you determine that performance of the agreement will promote, and will not constitute an unreasonable risk to, the common defense and security, approve the agreement, and authorize its execution.

ACDA Director Adelman concurs in this recommendation. His views are at attachment 5.

Recommendation

That you sign the determination, approval and authorization at attachment 1 and the transmittals to the Congress at attachment 2. (The transmittals will be held until the agreement itself is signed.)

Attachments

1. Draft Determination, Approval and Authorization

2. Draft Transmittals to the Congress

3. Proposed Agreement for Cooperation Between the Government of the United States of America and the Government of the People's Republic of China Concerning Peaceful Uses of Nuclear Energy, including Agreed Minute

4. Summary of Basic Provisions

5. Views and Recommendations of Director of the Arms Control and Disarmament Agency

United States - People's Republic of China Peaceful Nuclear Cooperation Agreement

Summary of Basic Provisions

Article 1 and Annex I contain definitions.

Article 2 sets forth the scope of cooperation in the use of nuclear energy for peaceful purposes. The parties state their intent to cooperate in this area in accordance with the provisions of the agreement. Information, technology, material, facilities and components may be transferred under the agreement directly between the parties or through authorized persons, and shall be subject to the terms of the agreement and to such additional terms and conditions as may be agreed by the parties. Material, facilities and components will be regarded as having been transferred pursuant to the agreement only upon confirmation by the recipient party that such item or items are to be subject to the terms of the agreement. Sensitive nuclear technology, sensitive nuclear facilities, and major critical components cannot be transferred under the agreement; their transfer would require additional provisions as an amendment to the agreement. Each party will implement the agreement in accordance with its respective applicable treaties, national laws, regulations and license requirements concerning the use of nuclear energy for peaceful purposes.

Article 3 provides for the transfer of information in a variety of fields involving the peaceful uses of nuclear energy. These fields include research, development and use of reactors and nuclear fuel fabrication technology, the use of material and physical and biological research, medicine, agriculture and industry, nuclear fuel cycle research, including waste management techniques, health, safety, and environmental research and development, assessing the role nuclear power may play in international energy plans, and codes, regulations and standards for the nuclear energy industry. The agreement limits transfers of information and technology to that which the parties are permitted to transfer, thus excluding the transfer of restricted data, since special procedures under section 144 of the Atomic Energy Act must be followed to authorize such transfers.

Article 4 provides the basic enabling framework for the transfer of material, facilities and components. Except for small quantities of special nuclear material for use as samples, standards, detectors, targets, radiation sources and such other agreed purposes, the agreement limits authorized transfers of special nuclear material to low-enriched uranium. Low-enriched uranium may be transferred for use as fuel in reactors and reactor experiments, for conversion or fabrication, or for such other purposes as may be agreed by the parties. The quantity of nuclear material transferred shall not at any time be in excess of the quantity necessary for reactors or reactor experiments, and such other purposes as may be agreed by the parties.

Article 5 requires the parties' agreement for the retransfer of any material, facilities, components or special nuclear material transferred pursuant to the agreement and any special nuclear material produced through the use of any such material or facilities.

This article also specifies that neither party has any plans to enrich to 20 percent or greater, reprocess, or alter in form or content material transferred pursuant to the agreement or material used in or produced through the use of any material or facility so transferred. In addition, neither party has any plans to change locations for storage of plutonium, uranium 233 (except as contained in irradiated fuel elements), or high-enriched uranium transferred pursuant to the agreement or used in or produced through the use of any material or facility so transferred. If plans change, the parties will consult immediately and seek agreement within six months on long-term arrangements for such activities. The parties undertake to consider the activities favorably, and agree to provide pertinent information on their plans. Each party agrees not to act during this period. If a long-term arrangement is not agreed, the parties will promptly consult for the purpose of agreeing on an interim arrangement. Both parties agree to refrain from actions which either party believes would prejudge the long-term arrangement or adversely affect cooperation under the agreement. In essence, consequently, none of the activities referred to in this paragraph may be undertaken unilaterally; prior approval of the other party is required.

Finally, article 5 precludes the use of material, facilities or components transferred pursuant to the agreement and material used in or produced through the use of any material, facility or component so transferred for any nuclear explosive device, for research specifically on or development of any nuclear explosive device, or for any military purpose. The agreed minute makes clear that this obligation does not involve any nuclear activities and related research and development carried out by either party, as a nuclear weapon state, through the use of material, facilities, components and technology not subject to the agreement.

Article 6 requires that each party maintain adequate physical security measures, in accordance with the levels of protection set forth in Annex II, with respect to any material, facility or components transferred pursuant to the agreement and with respect to any special nuclear material used in or produced through the use of any material or facility so transferred. The measures applied shall, as a minimum, be comparable to the recommendations set forth in IAEA document INFCIRC/225/Rev.1, "The Physical Protection of Nuclear Material," or in any revision of that document agreed to by the parties. The Annex describes physical security levels applicable with respect to the use, storage, and transport of nuclear materials classified as categories I (requiring the most stringent levels of protection), II, and III. The parties agree to consult at the request of either party regarding the adequacy of physical security measures, and agree to identify those agencies and authorities responsible for ensuring that levels of physical security are adequately met and having responsibility for coordinating response and recovery operations in the event of unauthorized use or handling of materials subject to the article.

Article 7 accords each party the right to cease cooperation if the other party does not comply with the provisions of the agreement. Each party undertakes to endeavor to avoid taking actions that would affect cooperation under the agreement.

Article 8 provides that parties shall consult at the request of either party regarding the implementation of the agreement, the development of further peaceful nuclear cooperation, and other matters of mutual concern. It is recognized that since the parties are both nuclear-weapon states, bilateral safeguards are not required. However, in order to exchange experience, strengthen technical cooperation between the parties, ensure that the provisions of the agreement are effectively carried out, and enhance a stable, reliable and predictable nuclear cooperation relationship, in connection with transfers under the agreement the parties will use diplomatic channels to establish mutually acceptable arrangements for exchanges of information and visits to material, facilities and components subject to the agreement. The parties also agree to exchange views and information on the establishment and operation of their respective national accounting and control systems for source and special nuclear material subject to the agreement.

Article 9 provides that the parties shall consult to identify the international environmental implications arising from activities under the agreement, and shall cooperate in protecting the international environment from radioactive, chemical or thermal contamination arising from such activities and in related matters of health and safety.

Article 10 establishes a thirty-year term for the agreement which may be extended by agreement of the parties in accordance with their respective applicable procedures. In the event of suspension, termination or expiration of the agreement or of cooperation thereunder for any reason, articles 5, 6, 7, and 8 shall continue in effect so long as any material, facility or components subject to these articles remains in the territory of the party concerned or any material, facility or components subject to these articles remain subject to that party's right to exercise jurisdiction or direct disposition elsewhere.

UNITED STATES ARMS CONTROL AND DISARMAMENT AGENCY
WASHINGTON

July 19, 1985

OFFICE OF
THE DIRECTOR

MEMORANDUM FOR THE PRESIDENT

SUBJECT: Nuclear Proliferation Assessment Statement for the Peaceful Nuclear Cooperation Agreement Between the United States and China

Pursuant to Section 123a. of the Atomic Energy Act of 1954, as amended, I am submitting to you an unclassified Nuclear Proliferation Assessment Statement on the agreement for cooperation between the United States and China. This statement addresses the background (Part I), the statutory requirements (Part II), and the non-proliferation policy issues (Part III) as they relate to the agreement.

China has recently taken major and welcome steps in adopting policies that advance non-proliferation objectives. The prospect of peaceful nuclear cooperation with the United States and others played an important role in encouraging China to adopt these policies. China understands that US cooperation under the agreement is contingent upon China's implementation of these policies in a manner fully consistent with those basic non-proliferation practices and standards that were discussed and clarified during the negotiations with China.

I have concluded that the agreement meets all statutory requirements, and I have reached a favorable assessment of the adequacy of the provisions in the agreement to ensure that any assistance furnished under it will not be used to further any military or nuclear explosive purpose. The agreement substantially benefits US non-proliferation objectives, and it will provide a good opportunity for continuing consultations with China on non-proliferation issues. In light of all the above, I recommend that it be approved.

Kenneth L. Adelman

Kenneth L. Adelman

Attachment:

Nuclear Proliferation Assessment Statement.

NUCLEAR PROLIFERATION ASSESSMENT STATEMENT

Pursuant to Section 123 a. of the
Atomic Energy Act of 1954, as Amended,
With Respect to the Proposed Agreement for Cooperation
Between the United States of America
and the People's Republic of China
Concerning Peaceful Uses of Nuclear Energy

This Nuclear Proliferation Assessment Statement relates to the proposed Agreement for Cooperation between the United States of America and the People's Republic of China Concerning Peaceful Uses of Nuclear Energy. This agreement for cooperation (which, together with its accompanying Agreed Minute, is hereinafter called the "proposed Agreement") is concurrently being submitted to the President for his authorization for execution.

Section 123 a. of the Atomic Energy Act of 1954, as amended ("Atomic Energy Act"), provides that a Nuclear Proliferation Assessment Statement shall address the "adequacy of safeguards and other control mechanisms and the peaceful use assurances contained in the agreement for cooperation to ensure that any assistance furnished thereunder will not be used to further any military or nuclear explosive purpose." This assessment statement addresses the background on the nuclear program and policies of China (Part I); the nature and scope of cooperation contemplated in the proposed Agreement (Part II A), and how the applicable substantive requirements of the Nuclear Non-Proliferation Act (NNPA) and the Atomic Energy Act are met by the proposed Agreement (Part II B); other non-proliferation policy issues pertinent to this agreement (Part III); and the assessment, conclusions, views and recommendations of the United States Arms Control and Disarmament Agency (Part V). Part II B. responds to the requirements for a Proliferation Assessment Statement in Section 123a. of the Atomic Energy Act, as amended by both the Nuclear Non-Proliferation Act of 1978 and, more recently, by the Export Administration Amendments Act of 1985.

I. BACKGROUND

A. China's Civil Nuclear Program

China has recently begun to develop a civilian nuclear energy program and has ambitious plans for the installation of substantial nuclear electric power capacity by the year 2000. China hopes to double total energy output and efficiency of energy use by that time. The construction of nuclear power plants in energy-poor areas would help China reach those goals.

China sees its nuclear power program as a necessary part of its development and modernization efforts. China is faced with severe electric power shortages. This has not only limited the amount of electricity available for household consumption, but it has also adversely affected industrial production. Future industrial and economic growth will require increased electric power.

China has relied primarily on coal-generated electricity, especially in the northern and central portions of the country which possess rich fossil fuel deposits. In 1984, China's coal production increased 8% over 1983 to 772 million metric tons. However, the growing demands for coal from a spreading industrial base have begun to tax the transportation sector's infrastructure, particularly the railroads. As a result, coal-generated energy has become increasingly costly.

Petroleum usage as a percentage of total energy production has fallen. The output of petroleum has remained flat since 1978 and now accounts for 21% of the national energy supply, down from 24% in 1978. China has continued to export crude oil and some petroleum products in order to acquire badly needed foreign currency. It is estimated that oil and petroleum products constitute some 25% of current export earnings. Growing internal demands for oil may force China to reconsider its oil export policy.

Hydroelectric power also provides energy in China. However, the large dams required to expand China's present hydroelectric power supplies are regarded as costly to construct and often result in the loss of valuable agricultural land.

Because of these perceived energy requirements and conditions, the nuclear power alternative has gained acceptance in China. The Chinese leadership will consider the cost and benefits of foreign technological assistance necessary to build modern nuclear power plants and the longstanding traditions of Chinese self-reliance. Thus, China's nuclear power program most likely will be a two-track effort: some foreign plants will eventually be constructed, and an indigenous effort at reactor construction and fuel fabrication will be advanced.

It is estimated that China possesses sufficient uranium deposits to maintain a modest civil nuclear program. Specific and detailed information on uranium deposits is presently unavailable, largely because China has yet to explore fully the regions where uranium is likely to be found.

China's technological base for peaceful nuclear activities is primarily an outgrowth of its cooperation with the Soviet Union in the 1950's. During that time, hundreds of Chinese engineers and technicians were trained at Soviet universities and research facilities. The Soviets also provided the research reactor for the Beijing Institute of Atomic Energy (BIAE).

Three main centers of nuclear power research are located in Beijing, Shanghai, and Sichuan. Beijing has two nuclear research facilities -- BIAE and one at Qinghua University. BIAE has a heavy water research reactor furnished by the Soviet Union in 1958 and is focused largely on the development of heavy water reactor technology. The Nuclear Energy Institute of Qinghua University is the primary facility for training nuclear engineers in China.

The primary research facility near Shanghai is the Shanghai Nuclear Physics Institute (SNPI). It cooperates closely with the 728 Reactor Research and Design Institute described below. Both groups are working on the design of a light water nuclear power reactor similar to those used in the United States. The 728 Institute maintains a small research reactor to study control rod design, power distribution, and hydraulics.

The Southwest Reactor Engineering Research and Design Center (SWERC) is located in Chengdu, Sichuan Province. Like the facilities near Shanghai, SWERC is involved in research on nuclear power reactors. In addition, a large research and test reactor is operated at Ziajiang. In February 1981, China announced that the reactor had gone into high power operation; it is used to produce radioactive isotopes for oil exploration and medical uses.

China has announced plans to build at least ten nuclear power plants with a total generating capacity of 10,000 megawatts by the year 2000. PRC officials have stated that many of these projects will import foreign equipment and engineering services.

Chinese officials at various levels have announced plans for reactors in at least a dozen locations, from Hainan Island in the south to the Liaoning Peninsula in the north. However, it appears that only three projects are likely to be started in the near future:

Qinshan, Zhejiang ("728 Project"). This 300-megawatt, "Chinese-designed" power plant has been advertised as the prototype for China's indigenous nuclear industry. Two major reactor components -- the pressure vessel and the cooling pumps -- are to be supplied by Japan and West Germany, respectively. The Chinese press reported that construction began January 25, 1985, with the laying of the plant's cornerstone. The press account reported that all roads, water, and electricity lines for the plant were completed by the end of 1984, ahead of schedule.

Daya Bay, Guangdong. A joint venture company was formed January 18, 1985, for the purpose of constructing this power plant with twin 900 MW pressurized water reactors. Named the "Guangdong Nuclear Power Joint Venture Company", the company is owned 75% by the Guangdong Nuclear Power Investment Company (a PRC corporation) and 25% by the Hong Kong Nuclear Investment Company (a wholly-owned subsidiary of Hong Kong Power and Light). Years of negotiations have not yet resulted in any final contracts between the Chinese and the likely suppliers of equipment and services for the Daya Bay project.

Sunan ("Southern Jiangsu" or "East China"), Jiangyin County, Jiangsu. The Chinese press has announced the establishment of the "Dongnan Nuclear Power Development Company", responsible for constructing this plant on the southern bank of the Yangtze River, north of Shanghai. It will hold twin 1000 MW pressurized water reactors. Earlier this year, requests for quotation for construction of the Sunan Project were issued to France and West Germany. In the absence of an agreement for cooperation, US companies were not invited to bid.

The Chinese have had commercial consultations on the supply of nuclear power-related equipment with France, the United Kingdom, Canada, Sweden, the Federal Republic of Germany (FRG), Italy, Belgium, and Japan. Belgium, the FRG, and the UK have agreements for peaceful nuclear cooperation with China. China has also concluded such agreements with Argentina and Brazil that could lead to reciprocal supply arrangements.

The proposed Agreement is the culmination of over four years of US-China talks. Six rounds of intensive negotiations were held, both in Washington and Beijing, prior to initialling of the proposed Agreement on April 30, 1984, by Ambassador Kennedy and Commissioner Jia during President Reagan's visit to China.

Prior to seeking formal Presidential approval, it became necessary to engage in further discussions with China for the purpose of clarifying matters related to implementation of China's nuclear policies. These discussions took place through diplomatic channels and during visits of senior US officials to Beijing. The discussions concluded successfully on June 27, 1985. With a resolution of these additional questions, it was then appropriate to proceed with obtaining Presidential authority to sign the proposed Agreement.

B. Non-Proliferation Policy

China's non-proliferation policy and statements have evolved since the end of the Cultural Revolution. With the rise of the post-Mao leadership of Deng Xiaoping, China has moved toward more responsible and active participation on disarmament issues in general, and most recently on non-proliferation in particular.

During the 1960's and 1970's, China's declaratory posture argued that the spread of nuclear weapons to additional countries would diminish the power of the United States and the Soviet Union, and rejected the view that an increase in the number of nuclear-weapon states would enhance the risk of nuclear war. Chinese declarations even postulated that the introduction of nuclear weapons to nations in the Third World could increase the opportunity of revolution. During the negotiations of the Nuclear Non-Proliferation Treaty, and subsequently, China has criticized the Treaty as discriminatory. But at the same time, China's actions were more restrained than its declaratory policy.

In the early 1980's, the possibility of Chinese involvement in international nuclear commerce became a reality. This development presented a serious problem. China had assumed no international legal obligation nor had it adopted a policy to require International Atomic Energy Agency (IAEA) safeguards or other controls on its nuclear exports. Also, its broader posture on non-proliferation continued to raise concerns about whether China would avoid actions that could help another country acquire nuclear explosives.

Recently, China has taken a series of positive non-proliferation steps, moving to accept those basic non-proliferation practices and norms common to all suppliers. During the January 1984 visit to Washington of Premier Zhao, he stated that China does not "engage in nuclear proliferation ourselves, nor do we help other countries to develop nuclear weapons."

On May 15, 1984, in an address to the Sixth National People's Congress, Zhao repeated that China does not "engage in such proliferation by helping other countries to develop nuclear weapons." This statement to the People's Congress and its subsequent endorsement by the Congress is the Chinese Government's highest vehicle for the pronouncement of public policy.

China's position on nuclear non-proliferation was most recently stated publicly by Vice Premier Li Peng in January 1985. According to an interview published in Beijing, he said China has no intention, now or in the future, to help non-nuclear nations develop nuclear weapons. He also said that China's present and future nuclear cooperation with other countries would be confined exclusively to peaceful purposes.

Discussions have been held with the Chinese, since the proposed Agreement was initialled last year, in order to clarify implementation of certain aspects of its non-proliferation policy. These discussions made clear that the two governments have a common understanding of the essential steps needed to implement these policies, consistent with their mutual commitment to non-proliferation. Thus, we can expect that China's policy of not assisting non-nuclear-weapon states to acquire nuclear explosives will be implemented in a manner consistent with the basic non-proliferation practices common to the United States and other suppliers.

These discussions also provided the Chinese with a more complete description of US policies and laws that form the basis for peaceful nuclear cooperation with a country like China. Finally, these consultations also permitted discussion of China's intentions regarding IAEA safeguards on its civil nuclear program.

On January 1, 1984, China joined the IAEA. Chinese officials said during the course of negotiations on the proposed Agreement and in the ensuing discussions that, as a member of the IAEA, China would require IAEA safeguards on its nuclear exports to non-nuclear-weapon states. This policy was formally implemented in late 1984 when the China-Brazil civil nuclear cooperation agreement incorporated a reciprocal IAEA safeguards requirement for items transferred under the agreement.

II. COMPLIANCE WITH STATUTORY REQUIREMENTS

As shown below, the proposed Agreement meets all applicable requirements of the NNPA and the Atomic Energy Act, as amended.

Section 123 a. of the Atomic Energy Act, as amended by Section 401 of the NNPA, requires new or amended agreements for cooperation to include the terms, conditions, duration, nature and scope of the cooperation.

The nature and scope of the cooperation authorized by the proposed Agreement is described in Section A below.

The duration of the proposed Agreement is 30 years from its entry into force. Notwithstanding the suspension, termination or expiration of the proposed Agreement for any reason, certain specified articles will (as discussed below) continue in effect as long as any material, equipment or components subject to those articles remain subject to the People's Republic of China's right to exercise jurisdiction or to direct disposition elsewhere.

The most pertinent terms and conditions of the cooperation are discussed in Sections B, C, F, and G of this Part below.

A. Nature and Scope of Cooperation

(1) Permitted Cooperation

Article 2 sets forth in general terms the scope of the cooperation envisaged, and paragraph 3 thereof sets forth a procedure with repect to such cooperation as follows:

> Material, facilities and components will be regarded as having been transferred pursuant to this agreement only upon receipt of confirmation by the supplier party, from the appropriate Government authority of the recipient party, that such material, facilities or components will be subject to this agreement and that the proposed recipient of such material, facilities or components, if other than the recipient party, is an authorized person.

Nuclear material and equipment which under US law may be exported only under an agreement for cooperation are so designated in the licensing process, and confirmation that such items will be subject to the relevant agreement takes place during that time. The purpose of the above-quoted provision is to ensure that such nuclear exports are subject to the proposed Agreement and in addition to provide a procedure for bringing under the proposed Agreement other nuclear exports which the parties agree should be so transferred pursuant to the proposed Agreement.

Article 4 sets forth in more specific terms the scope of cooperation covered by the proposed Agreement. Article 4(1) states that the only special nuclear material to be transferred will be low enriched uranium ("LEU") (i.e., uranium enriched to less than 20% in the isotope 235) except as provided in subparagraph 4 of Article 4.

Article 4(4) authorizes the transfer of small amounts of special nuclear material for use as samples, standards, detectors, targets and other purposes as the parties may agree.

(2) Types of Cooperation Not Authorized

The proposed Agreement excludes the transfer of sensitive facilities and technologies. Article 2(4) provides that sensitive nuclear technology, sensitive nuclear facilities or major critical components "will require additional provisions as an amendment to this agreement." This constitutes a preclusion of such transfers under this proposed Agreement. The law does not require such a prohibition; but if such cooperation is authorized, the law requires that certain criteria be met in the agreement. If such transfers were to be contemplated at any time in the future, additional control mechanisms would need to be obtained either in an amendment to the proposed Agreement or in a new agreement. The term "sensitive nuclear technology" is defined at Article 1(17), "sensitive nuclear facilities" at Article 1(14) and "major critical components" at Article 1(16).

B. Specific Requirements for a New Agreement for Cooperation

Section 123 a. of the Atomic Energy Act provides that a new agreement for cooperation shall include nine specific requirements. These are quoted below, together with an explanation of how they are satisfied by the proposed Agreement.

(1) Safeguards and their Durability

Subparagraph (1) of Section 123 a. requires:

> "a guaranty by the cooperating party that safeguards as set forth in the agreement for cooperation will be maintained with respect to all nuclear materials and equipment transferred pursuant thereto, and with

respect to all special nuclear material used in or produced through the use of such nuclear materials and equipment, so long as the material or equipment remains under the jurisdiction or control of the cooperating party, irrespective of the duration of other provisions in the agreement or whether the agreement is terminated or suspended for any reason."

(2) Scope of Safeguards

Subparagraph (2) of Section 123 a. provides:

"in the case of non-nuclear-weapon states, a requirement, as a condition of continued United States nuclear supply under the agreement for cooperation, that IAEA safeguards be maintained with respect to all nuclear materials in all peaceful nuclear activities within the territory of such state, under its jurisdiction, or carried out under its control anywhere;"

Since China is a nuclear weapon state, the requirement for IAEA safeguards set forth in subparagraph 2 of Section 123 a. is not applicable.

Subparagraph (1) mandates that whatever safeguards are set forth in the agreement for cooperation shall apply to the items specified in that subparagraph as long as those items remain under the jurisdiction or control of the cooperating party. Paragraph 2 of Article 10 (2) of the proposed Agreement states:

> 2. Notwithstanding the suspension, termination or expiration of this agreement or any cooperation hereunder for any reason, the provisions of article 5, 6, 7, and 8 shall continue in effect so long as any material, facility or components subject to these articles remain in the territory of the party concerned or any material, facility or components subject to these articles remain subject to that party's right to exercise jurisdiction or to direct disposition elsewhere.

Article 5 deals with retransfers, reprocessing, enrichment, alteration and no use for military purposes. This article is examined in detail in the analysis of subparagraphs 3, 5, 7, and 8 of 123 a. Article 6 deals with physical security and is examined under the analysis of subparagraph 6 of 123 a.

Article 7 states in pertinent part:

> If either Party at any time following entry into force of this agreement does not comply with the

> provisions of this agreement, the Parties shall promptly hold consultations on the problem, it being understood that the other Party shall have the right to cease further cooperation under this agreement.

Finally, Article 8 states:

> 1. The parties shall consult at the request of either party regarding the implementation of this agreement, the development of further cooperation in the field of peaceful uses of nuclear energy, and other matters of mutual concern.
>
> 2. The parties recognize that this cooperation in the peaceful use of nuclear energy is between two nuclear-weapon states and that bilateral safeguards are not required. In order to exchange experience, strengthen technical cooperation between the parties, ensure that the provisions of this agreement are effectively carried out, and enhance a stable, reliable, and predictable nuclear cooperation relationship, in connection with transfers of material, facilities and components under the agreement the parties will use diplomatic channels to establish mutually acceptable arrangements for exchanges of information and visits to material, facilities and components subject to the agreement.
>
> 3. The parties shall exchange views and information on the establishment and operation of their respective national accounting and control systems for source and special nuclear material subject to this agreement.

Thus, Article 10 of the proposed agreement would apply U.S. rights regarding retransfer, storage, reprocessing, enrichment, alteration, physical security, exchanges of information and visits and the Chinese guaranty against military or explosive use irrespective of the duration of other provisions in the agreement or whether the agreement is terminated or suspended for any reason.

The right set forth in Article 8 for the United States to conduct visits to material, facilities and components subject to the proposed Agreement is an important means of assuring that the provisions of the proposed Agreement are carried out, in particular, the Chinese guaranty against military or explosive use. Indeed, Article 8 specifically states that one of the purposes of visits is to ensure that the provisions of the proposed Agreement are effectively carried out. Moreover, Article 8 states that visits shall be arranged "in connection with transfers" of items under the proposed Agreement. Mutually acceptable arrangements on visits will be established before exports under the proposed Agreement are approved. Also valuable for the purpose of assuring that the provisions of the proposed Agreement are carried out are those provisions calling for frequent consultations and for exchanges of information on national accounting and control systems. The requirements of subparagraph 1 of Section 123 a. are satisfied by the proposed Agreement.

(3) No Military or Explosive Use

Subparagraph (3) of Section 123 a. requires:

> "a guaranty by the cooperating party that no nuclear materials and equipment or sensitive nuclear technology to be transferred pursuant to such agreement, and no special nuclear material produced through the use of any nuclear materials and equipment or sensitive nuclear technology transferred pursuant to such agreement, will be used for any nuclear explosive device, or for research on or development of any nuclear explosive device, or for any other military purpose;"

Article 5 meets this requirement wherein China guarantees that:

> "Material, facilities or components transferred pursuant to this agreement and material used in or produced through the use of any material, facilities or components so transferred shall not be used for any nuclear explosive device, for research specifically on or development of any nuclear explosive device, or for any military purpose."

There is no reference to sensitive nuclear technology because, as noted above, Article 2(4) of the proposed Agreement provides that an amendment is required before sensitive nuclear technology could be transferred under the proposed Agreement.

During the negotiations, China sought assurance that the agreement did not affect its right, as a nuclear weapon state, to conduct nuclear explosive activities using materials, facilities, components, and technology that are not subject to the proposed Agreement. The Agreed Minute provided such assurance as follows:

> Both parties agree that the interpretation and implementation of article 5(3) shall not involve any nuclear activities and related research and development carried out by either party, as a nuclear weapon state, through the use of material, facilities, components and technology not subject to the agreement.

(4) Right of Return

Subparagraph (4) of Section 123 a. requires:

> "except in the case of those agreements for cooperation . . . with nuclear weapon states, a stipulation that the United States shall have the right to require the return of any nuclear materials and equipment transferred pursuant thereto and any special nuclear material produced through the use thereof if the cooperating party detonates a nuclear explosive device or terminates or abrogates an agreement providing for IAEA safeguards;"

Since China is a nuclear weapon state, the requirement for a right of return as set forth in subparagraph (4) of Section 123 a. ia not applicable. Article 7, however, makes clear that the United States has the right to cease further cooperation if China does not comply with the provisions of the Agreement.

(5) Retransfer

Subparagraph (5) of Section 123 a. requires:

> "a guaranty by the cooperating party that any material or any Restricted Data transferred pursuant to the agreement for cooperation and....any production or utilization facility transferred pursuant to the agreement for cooperation or any special nuclear material produced through the use of any such facility or through the use of any material transferred pursuant to the agreement, will not be transferred to unauthorized persons or beyond the jurisdiction or control of the cooperating party without the consent of the United States;"

Section 109 of the Atomic Energy Act requires that recipient nations also agree to obtain U.S. approval before retansferring any components, items and substances exported from the United States which the Nuclear Regulatory Commission ("NRC") has found to be "significant for nuclear explosive purposes." The NRC has identified a series of such components, items and substances in regulations contained in 10 CFR Part 110 which are subject to this retransfer requirement.

Article 5(1) of the proposed Agreement satisfies both retransfer criteria of the Atomic Energy Act by providing that material, facilities, or components or special nuclear material transferred pursuant to the proposed Agreement and special nuclear material produced through the use of such material or facilities, "shall not be retransferred to unauthorized persons or, unless the parties agree, beyond its territory."

(6) Physical Security

Subparagraph (6) of Section 123 a. requires:

> "a guaranty by the cooperating party that adequate physical security will be maintained with respect to any nuclear material transferred pursuant to such agreement and with respect to any special nuclear material used in or produced through the use of any material, production facility, or utilization facility transferred pursuant to such agreement;"

Article 6(1) of the proposed Agreement meets this requirement by providing a guaranty by China that

> "adequate physical security shall be maintained with respect to any material and equipment transferred to and under its jurisdiction pursuant to this agreement and with respect to any special nuclear material used in or produced through the use of any material or equipment transferred to and under its jurisdiction pursuant to this agreement."

With respect to the meaning of "adequate," Section 127(3) of the Atomic Energy Act, as added to the law by Section 305 of the NNPA, provides that physical security measures shall be deemed adequate if they provide a level of protection equivalent to that required by regulations promulgated by the NRC establishing levels of physical security (see NNPA Section 304(d) and 10 CFR 110.43).

The balance of Article 6 and Annex II to the proposed Agreement contain implementing provisions, such as a description of the levels of physical security contemplated and measures to be taken. These provisions are consistent with the Guidelines for Nuclear Transfers published by the IAEA in February 1978 and the above-mentioned NRC regulations.

Article 6(3) permits the United States to consult with China concerning the adequacy of physical security measures in China, and, in accordance with Article 6(4), the Chinese authorities responsible for physical security will be made known to the United States. These provisions will facilitate cooperation between the United States and China on physical security matters of mutual interest, and will also enhance U.S. ability to be assured as to the level of physical protection being maintained.

(7) Reprocessing, Enrichment or other Alteration

Subparagraph (7) of Section 123 a. requires:

> "a guaranty by the cooperating party that no material transferred pursuant to the agreement for cooperation and no material used in or produced through the use of any material, production facility, or utilization facility transferred pursuant to the agreement for cooperation will be reprocessed, enriched or (in the case of plutonium, uranium 233, or uranium enriched to greater than twenty percent in the isotope 235, or other nuclear materials which have been irradiated) otherwise altered in form or content without the prior approval of the United States;"

This criterion contains several restrictions. First, U.S. approval must be obtained prior to any reprocessing of material supplied under a new or amended agreement or of any material produced from such material or produced or used in a production or utilization facility so supplied (e.g., a reactor). Second, such approval must be obtained for enrichment, after export, of any uranium supplied under a new or an amended agreement. Third, such approval must be obtained for any alteration of weapons useable material or irradiated nuclear material which has either been supplied under a new or an amended agreement or produced from such material or used in any such equipment so supplied.

Paragraph 2 of Article 5 of the proposed Agreement states:

> Neither party has any plans to enrich to twenty percent or greater, reprocess, or alter in form or content material transferred pursuant to this agreement or material or facility so transferred. Neither party has any plans to change locations for storage of plutonium, uranium 233 (except as contained in irradiated fuel elements), or highly enriched uranium transferred pursuant to this agreement or used in or produced through the use of any material or facility so transferred. In the event that a party would like at some future time to undertake such activities, the parties will promptly hold consultations to agree on a mutually acceptable arrangement. The parties undertake the obligation to consider such activities favorably, and agree to provide pertinent information on the plans during the consultations. Inasmuch as any such activities will be solely for peaceful purposes and will be in accordance with the provisions of this agreement, the parties will consult immediately and will seek agreement within

> six months on long-term arrangements for such activities. In the spirit of cooperation the parties agree not to act within that period of time. If such an arrangement is not agreed upon within that period of time, the parties will promptly consult for the purpose of agreeing on measures which they consider to be consistent with the provisions of this agreement in order to undertake such activities on an interim basis. The parties agree to refrain from actions which either party believes would prejudge the long-term arrangements for undertaking such activities or adversely affect cooperation under this agreement. The parties agree that the consultations referred to above will be carried out promptly and mutual agreement reached in a manner to avoid hampering, delay or undue interference in their respective nuclear programs. Neither party will seek to gain commercial advantage. Nothing in this article shall be used by either party to inhibit the legitimate development and exploitation of nuclear energy for peaceful purposes in accordance with this agreement.

The first sentence in Article 5(2) states neither party intends to engage in any of the activities specified in Section 123 a. (7). Should China in the future desire to undertake reprocessing, enrichment or other alteration, consultations will be held to establish long-term arrangements for such activities and the United States has agreed to "consider such activities favorably." No reprocessing, enrichment or alteration will be conducted during the period that such consultations are underway. If no long-term arrangements are agreed within six months of the initiation of consultations, the parties will consult on measures that would allow such activities on an interim basis. China agrees to refrain from any reprocessing, enrichment or alteration if the United States believes such activities "would prejudge the long-term arrangements for undertaking such activities or adversely affect cooperation" under the proposed Agreement. Although set forth in two stages, the text of Article 5(2) clearly precludes, for the first phase, any reprocessing, enrichment or alteration while seeking to establish long-term arrangements for such activities. During the second phase when the United States and China are seeking to make interim arrangements, the Chinese cannot undertake reprocessing, enrichment or alteration if the United States objects on grounds that such activity "would prejudge the long-term arrangements or adversely affect cooperation." Thus China cannot unilaterally proceed with reprocessing enrichment or alteration in the face of U.S. objection. Article 5(2) accordingly satisfies the criterion of subsection 7 of Section 123 a.

(8) Storage

Subparagraph (8) of Section 123 a. requires:

> "a guaranty by the cooperating party that no plutonium, no uranium 233, and no uranium enriched to greater than twenty percent in the isotope 235, transferred pursuant to the agreement for cooperation, or recovered from any source or special nuclear material so transferred or from any source or special nuclear material used in any production facility or utilization facility transferred pursuant to the agreement for cooperation, will be stored in any facility that has not been approved in advance by the United States;"

The proposed Agreement authorizes retransfer of only small quantities of plutonium, uranium 233 or uranium enriched to greater than 20 percent in the isotope 235.

Article 4(1) provides:

> "Any special nuclear material to be transferred under this agreement shall be low enriched uranium except as provided in paragraph 4 of this article."

Article 4(4) states:

> 4. Small quantities of special nuclear material may be transferred for use as samples, standards, detectors, targets, radiation sources and for such other purposes as the parties may agree.

Special nuclear material is defined in subparagraph (7) of Article 1 as follows:

> "(i) plutonium, uranium 233, or uranium enriched in the isotope 235, or (ii) any other material so designated by agreement of the parties."

The proposed Agreement addresses any change in storage location for such small quantities of uranium 233, uranium enriched greater than 20 percent in the isotope 235 or plutonium in the same manner as it addresses reprocessing, enrichment or other alteration. (All these subjects are dealt with in paragraph 2 of Article 5 of the proposed Agreement which is set forth on page II-8 of this Assessment Statement.) As with reprocessing, enrichment or other alteration, China has agreed not to undertake any change in storage location while the Parties are seeking to establish long-term arrangements for such storage. During the second phase while the Parties are seeking interim arrangements, the Chinese cannot change the location for storage of the specified materials if the United States objects. Thus, U.S. approval for any change in storage locations for these materials is guaranteed.

The proposed Agreement contains a phrase excluding plutonium or uranium 233 in irradiated fuel elements from the approval requirements for changes in storage locations. This follows the approach set forth in other agreements for cooperation that the United States has entered into with other countries. This exclusion is consistent with the storage criterion in the Atomic Energy Act because it is designed to cover material directly useable in nuclear explosives. (Senate Report 95-467, pp. 22, 52-53.)

The proposed Agreement does not deal with initial storage locations, only changes in storage locations after the listed materials have been received. Normal practice with respect to the exports of the small quantities of the material specified in section 123(a)(7) includes specifying the storage location for such materials. Thus, at all times, storage locations will be approved by the United States.

(9) Sensitive Nuclear Technology

Subparagraph (9) of Section 123 a. requires:

> "a guaranty by the cooperating party that any special nuclear material, production facility, or utilization facility produced or constructed under the jurisdiction of the cooperating party by or through the use of any sensitive nuclear technology transferred pursuant to such agreement for cooperation will be subject to all the requirements specified in this subsction."

Article 2(4) of the proposed Agreement provides that an amendment shall be required for any transfer of sensitive nuclear technology, sensitive nuclear facilities, or major critical components. Since the guaranty required by this criterion relates only to material or facilities produced or constructed through the use of sensitive nuclear technology transferred under the proposed Agreement, it is inapplicable to the proposed Agreement unless and until it is amended to provide for the transfer of such technology.

C. NNPA Section 402 -- Additional Requirements

Section 402(a) contains additional enrichment controls quoted and discussed below.

> "Except as specifically provided in any agreement for cooperation, no source or special nuclear material hereafter exported

> from the United States may be enriched after export without the prior approval of the United States for such enrichment;"

Article 5(2) of the proposed Agreement, which deals with this restriction, is discussed above. By limiting the need to obtain U.S. consent to enrichment of twenty percent or greater in the isotope 235, the United States is approving enrichment up to twenty percent of material subject to the proposed Agreement.

Section 402(a) further requires that:

> "[N]o source or special nuclear material shall be exported for the purpose of enrichment or reactor fueling to any nation or group of nations which has, after the date of enactment of this Act, entered into a new or amended agreement for cooperation with the United States, except pursuant to such agreement."

As applied to the present case, this provision means that after entry into force of the proposed Agreement, no U.S. source or special nuclear material can be exported to China for enrichment or reactor fueling except pursuant to the proposed Agreement. This will foreclose transfers of source material for such purposes outside an agreement for cooperation, which would otherwise be possible under Section 64 of the Atomic Energy Act.

Section 402(b) of the NNPA provides that:

> "In addition to other requirements of law, no major critical component of any uranium enrichment, nuclear fuel reprocessing, or heavy water production facility shall be exported under any agreement for cooperation...unless such agreement for cooperation specifically designates such components as items to be exported pursuant to the agreement for cooperation."

Article 2(4) of the proposed Agreement provides that there may be no transfer under the proposed Agreement of a "sensitive nuclear facility" -- defined in Article 2(14) to include uranium enrichment, reprocessing, and heavy water production facilities as well as facilities for the fabrication of nuclear fuel containing plutonium -- or "major critical components" as defined in Article 2(16), unless the proposed Agreement is amended.

D. NNPA Section 307 -- Conduct Resulting in Termination of Nuclear Exports

Section 307 added Section 129 to the Atomic Energy Act, which prohibits nuclear exports to nations which engage in certain proscribed activities. The activities in Section 129 are those which are directly related to weapons acquisition or which could have a weapons-related motivation. Based on available information, it is believed that a finding under Section 129 that would preclude nuclear exports to China under the proposed Agreement is not warranted.

E. NNPA Section 309 -- Components, Items and Substances

Section 309 of the NNPA amended Section 109 of the Atomic Energy Act to authorize the NRC to determine that certain component parts, items and substances, because of their significance for nuclear explosive purposes, should be subject to its licensing authority. For such licenses, the NRC must find that the following criteria or their equivalent are met:

> "(1) IAEA safeguards as required by Article III(2) of the [NPT] will be applied with respect to such component, substance, or item; (2) no such component, substance, or item will be used for any nuclear explosive device or for research on or development of any nuclear explosive device; and (3) no such component, substance or item will be retransferred to the jurisdiction of any other nation or group of nations unless the prior consent of the United States is obtained for such retransfer."

The NRC promulgated regulations on May 19, 1978 (10 CFR Part 110) which identified certain reactor components and two substances -- heavy water and nuclear graphite (moderator materials) -- the export of which would be subject to these criteria. In the case of China, the first criterion is met because Article III(2) of the NPT only requires IAEA safeguards on exports to non-nuclear weapon states. The second criterion (no explosive use) is met by the language in Article 5(3). The third criterion (retransfer) can be met by having components and moderator material identified as being exported under the proposed Agreement, in which case Article 5(1) would apply. (The Atomic Energy Act does not require that such exports be transferred under an agreement for cooperation; however, they may be so transferred.)

III. OTHER NON-PROLIFERATION ISSUES

Any decision by the United States to engage in nuclear cooperation with another nation can raise a number of non-proliferation policy issues in addition to questions about the legal rights, guarantees, and safeguards contained in the applicable agreement for cooperation. These issues will vary from case to case. They could involve, for example, the scope of the cooperation envisaged under such an agreement, the precedential implications of particular provisions of such an agreement, the degree to which extending nuclear cooperation may foster other non-proliferation interests, or the general role of the state concerned in non-proliferation efforts. This part of the assessment statement addresses those policy issues which relate to the proposed Agreement.

A. China's Non-Proliferation Policy

The central policy issue concerns the relationship of the proposed Agreement to China's non-proliferation policy. As outlined in Part I, over the recent past China has come to accept the most critical norms and practices at the heart of efforts to prevent the spread of nuclear explosives to additional countries. China joined the IAEA, stated that it would require safeguards on its exports to non-nuclear weapon states, and committed itself not to help other countries acquire nuclear explosives. Those positive and welcome steps went hand-in-hand with China's interest and activities in obtaining foreign assistance for its civil nuclear program.

During the talks, the US made clear that a shared understanding on non-proliferation was essential to provide a framework for assistance to China's peaceful nuclear program. Discussions with other countries, including the United States, on nuclear cooperation also provided an opportunity for substantial exchanges on non-proliferation issues, practices, and norms. These exchanges elevated the political importance of this issue, and created a better understanding by the PRC of the significance of certain non-proliferation principles and practices.

As a nuclear-weapon state, China has demonstrated that it has the technological and scientific ability to build a nuclear bomb and the capability of producing weapons-usable fissile material. Until recently, it had announced no policies against assisting another state to acquire nuclear explosives. China is not a party to the Nuclear Non-Proliferation Treaty which contains obligations not to assist non-nuclear-weapon states in the manufacture or acquisition of nuclear explosives.

Thus, the potential for great harm to global non-proliferation efforts and barriers has been present.

Since January 1984 China made a series of statements stressing that its policy is not to assist other to acquire nuclear weapons.*

Discussions with China that have taken place since the initialling of the proposed Agreement have contributed significantly to a shared understanding with China on what it means not to assist other countries to acquire nuclear explosives, and in facilitating China's steps to put all these new policies into place.

Thus, ACDA believes that the statements of policy by senior Chinese officials, as clarified by these discussions, represent a clear commitment not to assist a non-nuclear-weapon state in the acquisition of nuclear explosives. On the basis of the discussions with the PRC, the United States can expect that China's policy of not assisting a non-nuclear-weapon state to acquire nuclear explosives will be implemented in a manner consistent with those basic non-proliferation practices common to the United States and other major suppliers.

This commitment applies to all future Chinese assistance. Moreover, the Chinese are fully aware of the importance of their non-proliferation policies to future US-China nuclear relations. They know that should we find out about any action inconsistent with these basic non-proliferation measures, including requiring IAEA safeguards on nuclear exports, we would not go forward with exports until the matter were resolved satisfactorly.

In joining the IAEA, China will be able to participate in implementing the basic principles of that Agency which include efforts to prevent the spread of nuclear explosives. China's presence in that international forum also will bring it into contact with other countries that support a strong non-proliferation and safeguards regime.

Because US-China peaceful nuclear cooperation must rest on shared principles of non-proliferation, it will be important for the United States to consult regularly with China on non-proliferation issues. We will also pay close attention to China's actions in this area. The United States has made clear to China that US-Chinese nuclear cooperation rests on strict adherence to these principles and common basic practices.

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*See pages 4-5 of Part I.

The proposed Agreement will provide a basis for further consultations between the United States and China on non-proliferation. These consultations can strengthen the mutual commitment to shared non-proliferation principles and establish a framework for cooperation in this area. Over time, such consultations may lead to further improvements in China's non-proliferation policies.

The United States has been cautious in cooperating with countries that are not parties to the Nuclear Non-Proliferation Treaty, given the importance of the Treaty in promoting non-proliferation. No such cooperation should be concluded in the absence of significant non-proliferation benefits. ACDA believes that the proposed Agreement meets this test.

In summary, as a country outside the non-proliferation regime, China posed a serious potential risk to international non-proliferation efforts. China has now declared its opposition to proliferation and taken concrete steps toward global non-proliferation norms and practices. Along with the discussions with other countries, the prospect of the proposed Agreement played an important role in bringing about this evolving attitude on the part of China.

B. "Consultations and Visits"

As noted in Part II, the proposed Agreement meets all of the requirements of US law, including a pledge that material and equipment subject to the agreement will not be used for nuclear explosives or any military purpose. The provisions of the proposed Agreement which relate to the ability of the United States to verify this assurance are unique and recognize that China is a nuclear-weapon state.

The United States is not obligated, either by domestic law or by the nuclear export provisions of the Nuclear Non-Proliferation Treaty, to condition nuclear exports to nuclear-weapon states on the acceptance of IAEA safeguards. Even so, the United States did seek Chinese acceptance of IAEA safeguards on US supply under the agreement, but the Chinese adamantly refused -- as they have to date with other nuclear-weapon states. (The Chinese reportedly did agree to IAEA safeguards on any "sensitive" assistance they receive from the UK. The US-China agreement does not permit cooperation in those areas defined as "sensitive nuclear technology" under US law, nor in other "sensitive" areas such as exports of significant quantities of highly enriched uranium or plutonium.)

Acceptance of IAEA safeguards by nuclear-weapon states can serve to minimize discrimination against non-nuclear weapon states, and thus can help to sustain broad political support for international non-proliferation institutions such as the IAEA safeguards system. For that reason, the United States, United Kingdom, France, and the Soviet Union have all voluntarily permitted the IAEA to apply its safeguards on at least some of their respective civil nuclear facilities. As noted above, it appears China has agreed in principle to accept IAEA safeguards on imports from certain non-nuclear-weapon states. As a practical matter, however, there are no such safeguards yet applied in China.

Article 8 of the agreement provides for "mutually acceptable arrangements for exchanges of information and visits" in connection with transfers under the agreement. These arrangements will be established through diplomatic channels prior to the licensing by the United States of nuclear exports under the agreement, and will include provision for exchanges of information and visits by US personnel to relevant sites in China where US material or equipment subject to the agreement is located. The United States and China will also exchange views and information on their respective national accounting and control systems for nuclear material subject to the agreement.

The scope of cooperation permitted by the proposed Agreement also is important when considering provisions related to verification. Cooperation under the agreement is limited to reactors, their major components, and low enriched uranium fuel. As noted previously, it does not authorize the export of more than gram quantities of plutonium and highly enriched uranium, nor does it authorize the export of sensitive facilities capable of producing such material. A separate agreement -- including Congressional review -- would be necessary to authorize the transfer of such items. Moreover, as described below, mutually agreed arrangements for reprocessing are provided in the agreement.

As a nuclear-weapon state, China has nuclear facilities dedicated to the production of fissile material for nuclear weapons. Any effort by China to divert material from a civil facility for military purposes would result in the termination of any US assistance to China's civil nuclear program, and in all probability that of other foreign suppliers as well. Both factors reduce any incentive for China to divert material or equipment from its civil program.

Given these circumstances, ACDA believes that the provisions of the proposed Agreement are adequate to provide confidence against the misuse of any items subject to the proposed Agreement. ACDA has considerable experience in designing systems aimed at deterring the diversion of any nuclear material from peaceful to military uses, and expects to participate actively with other relevant agencies in establishing the mutually acceptable arrangements in connection with proposed exports under the agreement.

C. Consent Rights

As noted in Part II, ACDA believes that the relevant provision in the proposed Agreement (Article 5, paragraph 2) satisfies the statutory requirement of US consent rights over certain fuel cycle activities, including reprocessing. The Chinese have stated that they have no plan to undertake reprocessing of spent fuel from power reactors for at least fifteen years. In fact, there is no existing facility in China capable of reprocessing such fuel.

Should China desire to undertake any of these activities, the United States and China will attempt to reach agreement within six months on long-term arrangements to govern the conditions for such activity. These long-term arrangements could take many forms.

In particular, ACDA believes that in connection with any future discussions on long-term arrangements and the possible exercise of the United States consent rights over reprocessing, it will be important to ensure that the procedures called for under Article 8 are adequate to help verify that any separated plutonium is being used consistent with the provisions of the agreement. Any procedures for information exchange and visits previously agreed for the transfer of reactors and low enriched uranium fuel may not be sufficient for separated plutonium. However, the provisions of the proposed Agreement are fully adequate to ensure that such arrangements are agreed before any reprocessing takes place. ACDA fully supports the outcome on consent rights; it solved the last major obstacle in the negotiations prior to the April 1984 initialling, and preserved the significant non-proliferation benefits of the proposed Agreement.

D. Summary

The proposed Agreement is unique in comparison to other agreements for cooperation concluded since the Nuclear Non-Proliferation Act. It is the first such agreement with a nuclear weapon state since the passage of that Act. Further, China had only recently accepted the basic norms and practices of non-proliferation. An appreciation of this context is essential in making a balanced judgment on the non-proliferation benefits of the proposed Agreement.

China's desire to obtain foreign assistance for its civil nuclear program provided an opportunity for substantial discussions with the United States and other suppliers on the major features of the non-proliferation regime. Moreover, the prospect of assistance was a major incentive for considerable evolution of China's position on non-proliferation.

China has joined the IAEA, and stated that it will require IAEA safeguards on its nuclear exports. China has committed itself not to assist other countries to acquire nuclear explosives. And the United States can expect that China's policy of not assisting a non-nuclear-weapon state to acquire nuclear explosives will be implemented in a manner consistent with those basic non-proliferation practices common to the United States and other major suppliers. The Chinese are also fully aware that their continued support for and effective implementation of these basic practices is a sine qua non for US nuclear cooperation under the proposed Agreement.

Entry into force of the proposed Agreement would contribute importantly to the ability of the United States to continue working with China in non-proliferation. The agreement not only recognizes the evolution in China's non-proliferation policies, but also provides a framework for continued exchanges in this area.

IV. CONCLUSIONS

On the basis of the analysis in this assessment statement and all pertinent information of which he is aware, the Director of the United States Arms Control and Disarmament Agency has:

- concluded that the proposed Agreement meets all of the substantive requirements in the Atomic Energy Act and the NNPA applicable for new or amended agreements for cooperation.

- reached a favorable net assessment of the adequacy of the provisions of the proposed Agreement to ensure that any assistance furnished thereunder will not be used to further any military or nuclear explosive purpose.

- concluded that execution of the proposed Agreement would advance the non-proliferation program, policy, and objectives of the United States; and

- joined in the recommendation of the Secretary of State and the Secretary of Energy that the President determine that the performance of the proposed Agreement will promote, and will not constitute an unreasonable risk to, the common defense and security, and that the President approve and authorize the execution of the proposed Agreement.

Office of Technology Assessment

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Requests for studies are made by chairmen of standing committees of the House of Representatives or Senate; by the Technology Assessment Board, the governing body of OTA; or by the Director of OTA in consultation with the Board.

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OTA-TM-ISC-30

SEPTEMBER 1985